Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MARCH, 1914.

COMMENTS.

THE PUBLIC UTILITY OF MUSEUMS.—On January 31st Lord Sudeley gave an address to teachers under the auspices of the Education Committee of the London County Council.

It will be remembered that Lord Sudeley has for some time very strenuously advocated the employment of guide-demonstrators in public museums, and in his address he was able to give figures which showed that the interest taken by the public in institutions where they can avail themselves of the services of a guide has enormously increased. Members of natural history societies who have spent an afternoon in a museum with one of the staff to explain matters will know what a difference it makes to have someone at hand who is really conversant with what the specimens are and what they show.

We sincerely hope that Lord Sudeley will continue to press for the appointment of guides in institutions of all kinds of an educational character.

In the address a good deal was said about the taking of children to museums by their teachers. We know from experience that some teachers could do a very great deal when acting as guides, and that all could do something. But we think that the most successful guide would be one who had much greater opportunities of familiarising himself with the collections or who has actually arranged and labelled them.

We are not sanguine of teachers finding a new profession as guide-demonstrators, and we rather think that it is good for children sometimes to listen to words from a person who is not their regular instructor.

We would like to remind our readers that Lord Sudeley has hitherto interested himself in museums intended for the general public. There is another important aspect of the subject, and that is the establishment of special museums or collections intended primarily for children. An article in which this is dealt with appears on page 89 of the present number.

Mr. John W. Gilbert, the Chairman of the London Education Committee, on the occasion of Lord Sudeley's address, mentioned the enormous number of children in London, and the difficulties of arranging for sufficiently small numbers to go on the journeys, which are often exceedingly long. It is surprising that the alternative of taking specimens to the children, which has been carried out with success in some localities, has not been developed much further. Remarks on this also will be found in the article already mentioned.

THE PLUMAGE QUESTION.—Mr. S. L. Bensusan, who is one of the Honorary Secretaries of the Committee for the Economic Preservation of Birds, on February 16th, gave a very telling account of the plumage question, and of the successful attempts which his Committee has made really to do something at last which will protect birds from extinction.

Repeated attempts have been made to obtain legislation which will prevent the importation of certain feathers into this country. These have not been successful. In cases where laws have been passed, as in Australia and India, valuable plumage is still sent out of the country under the rose.

The latest Bill introduced into Parliament prohibits the importation of all feathers except

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the plumage of the ostrich and eiderdown. If such an one becomes law it merely means that the goods heretofore consigned to England will go to France, for that country will not follow suit with a similar prohibition, and there are many other European countries which would have to be won over if it did.

The Committee for the Economic Preservation of Birds has begun, with the concerted help of the trade representatives in London, Paris, Berlin, and Vienna, to make a list of birds in which the merchants and brokers will no longer deal. Surely this is the commonsense method which should appeal to everyone who does not allow sentiment to run away with them; and, as Dr. Chalmers Mitchell, the Chairman of the Committee, said, those who seek to protect birds in another way should not attribute motives to those who work differently.

We noted in our September issue, 1913, that through the action of the Selborne Society the Committee for the Economic Preservation of Birds came into existence, and now that the representative members of that Society have made a report, the Council has unanimously resolved that, "while not departing in any way from its policy of discouraging the wearing of plumage, is of opinion that its object of preserving birds which are harmless, beautiful, or rare, may for the present be best accomplished by such international arrangements as are being made by the Committee for the Economic Preservation of Birds."

The report which appears in the current number of *The Selborne Magazine* is as follows:—

The members representing the Council of the Selborne Society on the Committee for the Economic Preservation of Birds have pleasure in reporting that the attempt which the Committee has made to bring about the protection of birds by means of international agreement on the part of the plume trade has been most successful.

In the first place a German Committee for the Economic Preservation of Birds has been established in Berlin, and has adopted the programme of the London Committee in its entirety. Professor Reichenow and Dr. Heinroth are among the German ornithologists who have joined the Berlin Committee.

A French Committee has been brought into existence, of which the French Minister of Commerce has become the Honorary President, while the French merchants, through the presidents of their Intersyndical Chambers, have formally agreed to accept the findings of the London Committee, and have themselves suggested certain birds which they think should be protected.

The merchants of Vienna, through their Chamber of Commerce, have undertaken, in writing, to accept the findings of the London Committee.

The leading London merchants and brokers have signed a like undertaking.

At a meeting, held on December 15th, 1913, the following birds were put on the protected list:—

The family of Cotingidae (Chatterers).
The Resplendent, or Longtailed Trogon.
The Lyre Bird,
The Rifle Bird,
The Regent Bird,
} of Australia.

At a meeting on January 26th, 1914, the Flamingo and the Spoonbills were added to the list, while, on February 9th, the Cattle-Egret, of India, was recommended for protection as well as a number of birds found to be useful to agriculture in France.

The Australian birds and the Indian Egret, abovementioned, by law are not allowed to be exported, but they continue to be smuggled out and brought to this country; hence the action of the Committee. Other birds are being considered, and evidence is being collected with regard to the plumage question from all parts of the world.

LONDON PARKS.—*The Gardener's Chronicle* has a spirited protest against the cutting down of trees in London Parks in order to make way for the playing of children's games. The suggestion has been very rightly put forward that grown-up people who wish to take advantage of the small amount of rusticity to be found in the Metropolis should be considered, and it is to be hoped that if the abuses which *The Gardener's Chronicle* outlines exist, the residents in the neighbourhoods of the parks which are likely to be damaged will unite and take action.

THE SOCIETY FOR THE PROMOTION OF NATURE RESERVES.—Our readers will remember the articles which Mr. William Rowan has written in these pages on the bird-life of Blakeney Point, which has been secured through the action of the Society for the Promotion of Nature Reserves. Our review of *The Journal of Ecology* on page 105 will also show the advantage which scientific men and students are taking of their opportunities at Blakeney. We therefore should like to emphasise the need which exists of supporting the Society in question.

It in no way interferes with the objects of any other existing society, and any tracts of land which it is able to preserve it hands over to the care of the National Trust. Its President is the Speaker, the Rt. Hon. J. W. Lowther, and among the Council are Dr. Bailey Balfour, Sir Francis Darwin, Mr. G. Claridge Druce, Professor Farmer, Sir Edward Grey, Mr. L. V. Harcourt, Mr. E. S. Montagu, Professor Poulton, Sir David Prain, and Mr. Charles Rothschild.

The first object of the Society is to collect and collate information as to areas of land in the United Kingdom which retain their primitive condition, and contain rare and local species liable to extinction owing to building, drainage, and disafforestation, or in consequence of the cupidity of collectors. Furthermore, the intention is to obtain some of these areas if possible and to preserve for posterity as a national possession some part at least of our native land, its fauna, flora, and geological features. Lastly, the Society exists to encourage the love of nature, and to educate public opinion to a better knowledge of nature study.

Any information which is given to the Society will be treated as strictly confidential, and details as to any suitable reserves should be sent on one of the red forms, which, with information as how to help on the work, may be obtained from the Honorary Secretaries, Mr. W. R. Ogilvie-Grant, and the Hon. F. R. Hendley, Care of the British Museum (Natural History), Cromwell Road, London, S.W.

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STELLAR SPECTROSCOPY FOR BEGINNERS. V.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

A LARGE part of the work of the astrophysicist is associated with spectrograms, and it is said there are not a dozen astrophysicists altogether. Perhaps this is true, for doubtless an astrophysicist should be a physicist first and then an astronomer. Essentially he needs to know, extraordinarily well, molecular physics and thermodynamics, theoretical optics and the dynamical theory of gases. His experience in the work of the professional astronomer of the past may be of the slightest. The tremendous bound forward of modern astronomy has been almost wholly the work of astrophysicists. Hence it is highly desirable that a greater knowledge of the basic principles on which the progress of this new science depends should be widely known and its scattered workers all over the world be brought into touch. We want an International Astrophysical Society.

A large part of Astrophysics involves problems relating to energy.

ENERGY.

In this article we are dealing with the vibrations of atoms and their speed in space; and both are questions of energy. Energy is the capacity for doing work: it is of two kinds, kinetic and potential; that is, the energy of motion and of position or of strain. Energy of position is of as many kinds as there are physical forces. Objects removed under the stress of attraction, or brought together against the stress of repulsion, acquire potential energy. Lift a brick on to a tower and it then possesses potential energy; let it drop and the energy of position becomes energy of motion, and the working power of the motion of the whole brick (its mass motion) is called molar kinetic energy (from Latin *moles*, a mass). When it falls on the pavement the shock causes it to quiver internally; the motion becomes molecular and atomic, and this kind of indiscriminate quiver we call heat, or molecular kinetic energy.

Hot things radiate, and radiation appears to be this internal atomic or molecular motion communicated to the ether. It is convenient to regard the ether as an all-prevailing elastic jelly-like solid. The more we know of radiation, the more difficult it becomes to grasp the full character of the ether. As its vibrations can be transverse, it seems best to think of it as a jelly of extreme elasticity that is very incompressible. The ether communicates its vibrations to the hand as warmth, and to the eye as light. Students of spectroscopy must carefully differentiate between molar motion and molecular heat motion, especially in gases. Important stellar problems have been left unsolved by astronomers for lack of this differentiation. Wind is molar motion of gas; the heat of a flame is atomic and molecular motion. The upward motion of a flame is molar motion.

ATOMIC VIBRATIONS.

For the last forty years I have pictured an atom as a nucleus with an elastic electrically non-conductive exterior, and the more we know of the structure of atoms the better the idea seems to hold. When atoms are struck they vibrate, and the sharper the blow, the more overtones seem to be produced. We can give velocity to atoms by heat and by electricity; in stellar space atoms also acquire velocity by the attraction of gravitation. The higher the potential of electricity, and the greater the temperature at which atoms strike, the faster is the internal vibration produced, and the higher the pitch of the overtones. We have already discussed the complex characters of the varied series of the overtones of atoms of different elements.

The more frequent the luminous vibrations are, the further they appear toward the ultra-violet end of the spectrum. The luminous influence of temperature, as already mentioned, is perhaps best shown by having a thin upright heated platinum wire, and viewing it through a prism in a card at a long distance away (see Figure 62). Pass a current through the wire and bring it to a low, red heat; then keep lessening the electrical resistance of the circuit; the current increases, and the wire gets hotter. As it does so the red patch of light seen through the prism extends progressively towards the violet, adding orange, yellow, green, blue, and indigo, until it becomes a full and beautiful spectrum. When it is red there is very little light; the thermal radiation is then some hundred of times greater than the luminous. As the temperature rises the ratio of light to heat increases until we get sunlight with half the radiant energy luminous. Hence a very high temperature produces a cool light. To illustrate, compare the radiant energy from a glowing fire and an "Osram" lamp. On switching off the lamp the room is dark, yet one does not notice any difference in the warmth. As the temperature rises the light becomes whiter. Compare a candle with a carbon incandescent burner, and it looks yellow; in its turn the carbon looks yellow beside the metal filament, and this looks yellow beside an arc light. The whitest light is the electric spark from a Leyden jar, and this is the means of producing a spectrum that seems to indicate that the atoms have been shaken more than by any other method.

We are justified in thinking that the closer atoms get to the solar and stellar photospheres the hotter

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they become, and the higher the overtones that are produced. This shows beautifully in the enlargement of the Worthington spectrogram in the December number of "KNOWLEDGE." All the lower hydrogen overtones are perfect rings, because they extend high in the chromosphere. But the quick overtones, as we go towards the violet end, are only segments of circles, getting shorter and shorter. This shows that these high overtones were only produced by atoms near the photosphere. It also gives an idea of the stupendous temperature of the stars in which the hydrogen bands can be traced far beyond the Omega line.

Just as it is possible to strike a tuning-fork or a bell with a small hard object, and get sharp overtones and yet scarcely hear the lower tones at all, so it seems to be the case with atoms. By different modes of exciting atoms quite different spectra are produced; the lowest kind is by a spirit-lamp, next the bunsen burner, then the hot-blast blowpipe, and the highest temperature of all is the electric arc. But when electricity is used the effect is mixed. Doubtless, as I showed in *The Philosophical Magazine* some forty years ago, the blow an atom gets may be due to heat, or to electricity, or to both combined. Of electrical methods we have the ordinary vacuum tube with capillary neck, the ordinary electric arc, the spark, and the spark intensified by a Leyden jar. Then the degree of exhaustion—that is, the pressure—also influences the kind of spectrum, the width of bands, and so on.

DISPLACEMENT AND BROADENING OF LINES, AND REVERSION.

We have now treated of the excitation of the atom and its complex overtones; we shall discuss a little more fully some of the effects of other physical agencies upon the radiation that has been produced. These agencies are of two chief kinds, the effect of the relative motion in space, either of the observer or the singing atoms, and the effect of the absorption by atoms of radiant energy. We shall take relative motion in space first.

INFLUENCE OF RELATIVE MOTION.

The idea of Doppler's principle was based on a somewhat exaggerated notion, so far as the facts it was intended to explain were concerned. But the detection of new principles is rare enough; we cannot afford to waste this gold of thought because it contains earthy gangue, and is not yet minted into the current coin of science. It is very important that scientific men should separate the nuggets of golden thought from the spurious mundic of error, and not put a hall-mark upon counterfeit coin. But the way human progress has been retarded by the inhospitality of officials towards new generalisations is nothing short of a world tragedy.

This inhospitality has been not merely against new theories, but against new correlations based on rational new scientific principles, founded on scientific laws, and attested by many facts. Also they have slept even when the anticipating deductions have been backed up by the most striking observational evidence. Sir Ronald Ross has attacked this lethargy in the current number of *Science Progress* in a most masterly article.

DOPPLER'S PRINCIPLE.

The principle is that a vibrating body giving off waves has those waves closed up (that is, the waves become shorter and the pitch increases) if the body is approaching; and has its waves opened out and the pitch becomes lower if it is receding, and the distance between the vibrating object and the observer is increasing. Doppler appears to have discovered this principle when trying to explain the colours of stars. He seems to have imagined that the luminous vibrations of stars had definite limits of wave-length, which the work we have already studied shows to be to some extent true.

Distinctly stars have a tint. He thought that if stars were approaching us they would have a blue tint, and if receding a red tint. We now know that blue stars may be going away, and red stars may be approaching. Any given pure tint is altered either towards the red or the violet, but with the ordinary velocity of stars a general change of colour could not be detected. Although founded on a great exaggeration, yet this idea of change of wave-length is one of the most important principles of spectroscopy. Lord Rayleigh thinks it very far-reaching in explanation, and I certainly agree with him.

Fortunately Doppler's principle was seen to be true, and has been used to explain almost endless phenomena. If mankind had been as ready to reject metals because of the gangue as we are to neglect correlation containing much truth because there is some error we should still be in the Stone age. What we want is a kind of scientific court of claims where a new generalisation could be investigated; a solitary worker is very liable, amidst much truth, to overestimate a principle; and effects may creep in that exaggerate a phenomenon. In my description of the well-known change of pitch in passing trains I must have mixed two agencies. I find on calculating the effect of two trains, each passing at about a mile a minute, the drop of the note would be less than an octave. When the whistling train passed us the flattening unconsciously struck me, but the very low note that followed was not the whistle—it was merely the rumble of the passing train. Since I made the calculation I have not passed a whistling train, but have passed trains and noticed that their rumble has a kind of rough pitch. Most people's ears have been trained by listening to good music, so that even a very slight flattening of a note is quite perceptible.

A given spectral line is simply displaced by the movement of the star, or other luminous body, towards or away from us; but if the atoms of a

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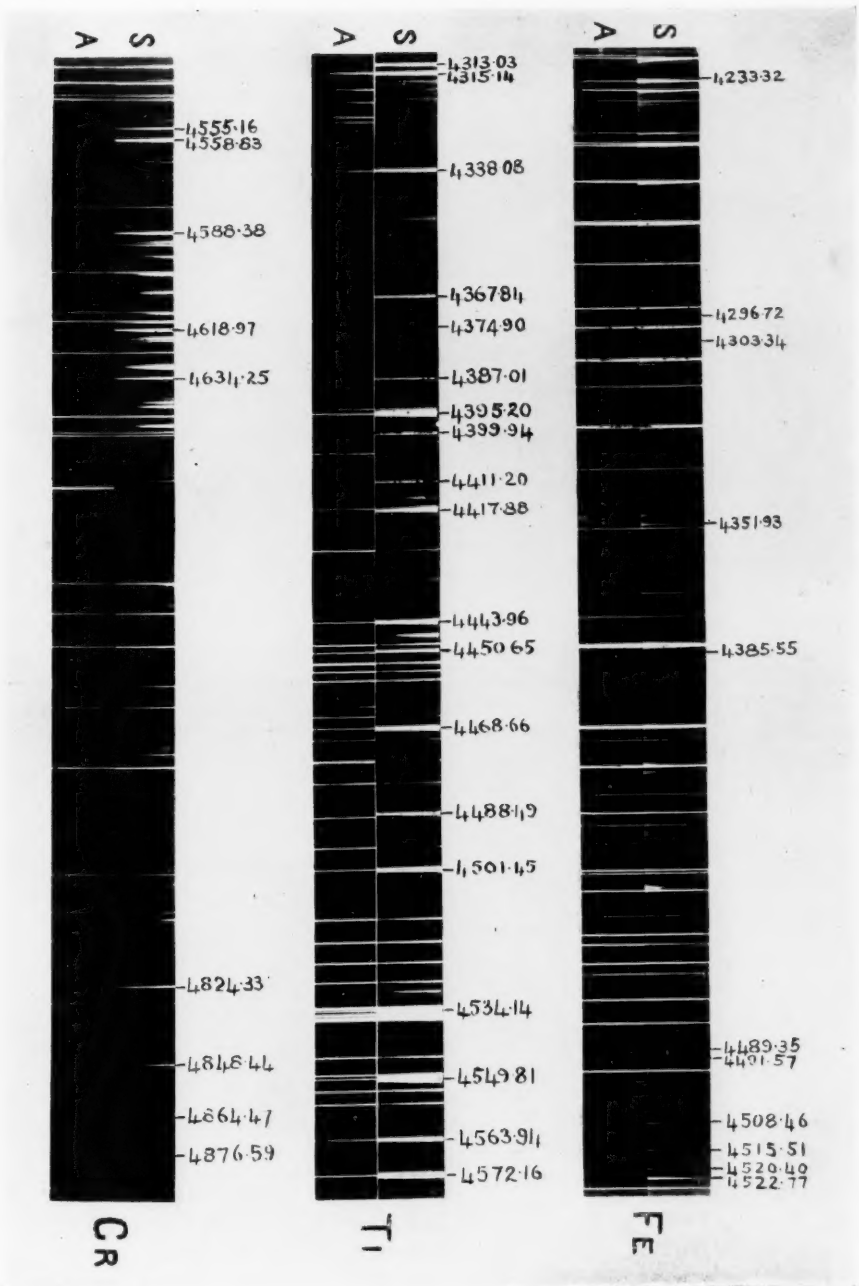

FIGURE 61.

The two spectra of iron and titanium lie between wave-lengths 4313 and 4572; in the case of chromium between 4530 and 4876. In each case a very little piece of the whole spectrum is shown, not much more than a twentieth. The series is a remarkable illustration of the beautiful work that was done at the Solar Physics Laboratory at South Kensington.

In the spark spectrum of iron (Fe), the pole is shown at the bottom; in the case of titanium and chromium the spark pole is at the top.

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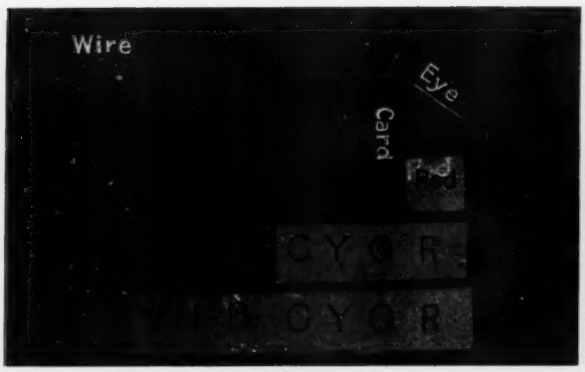

FIGURE 62.

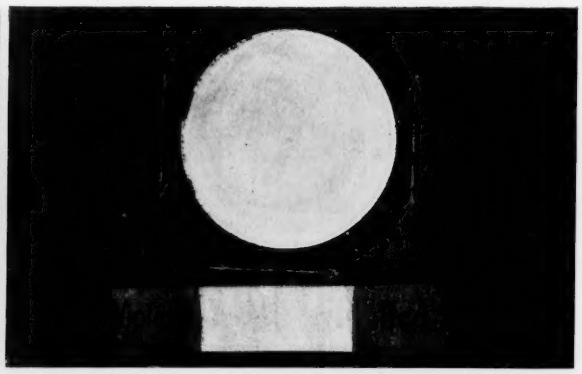

FIGURE 64.

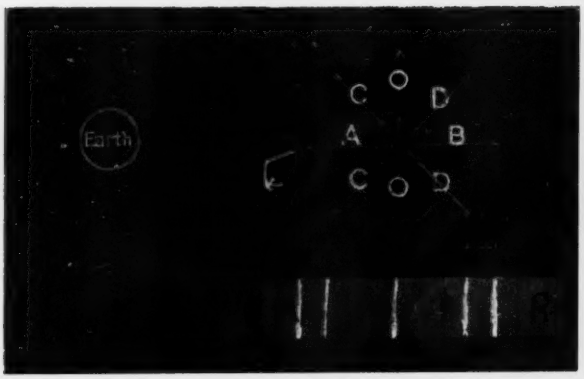

FIGURE 63.

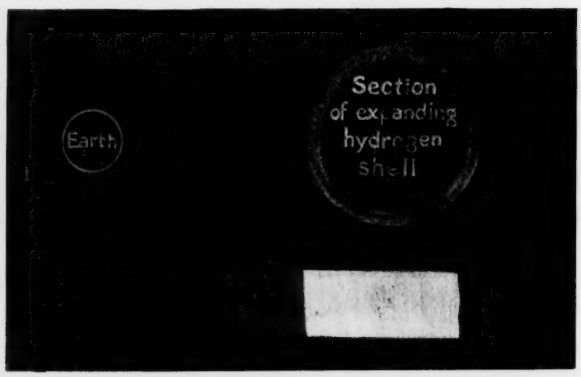

FIGURE 65.

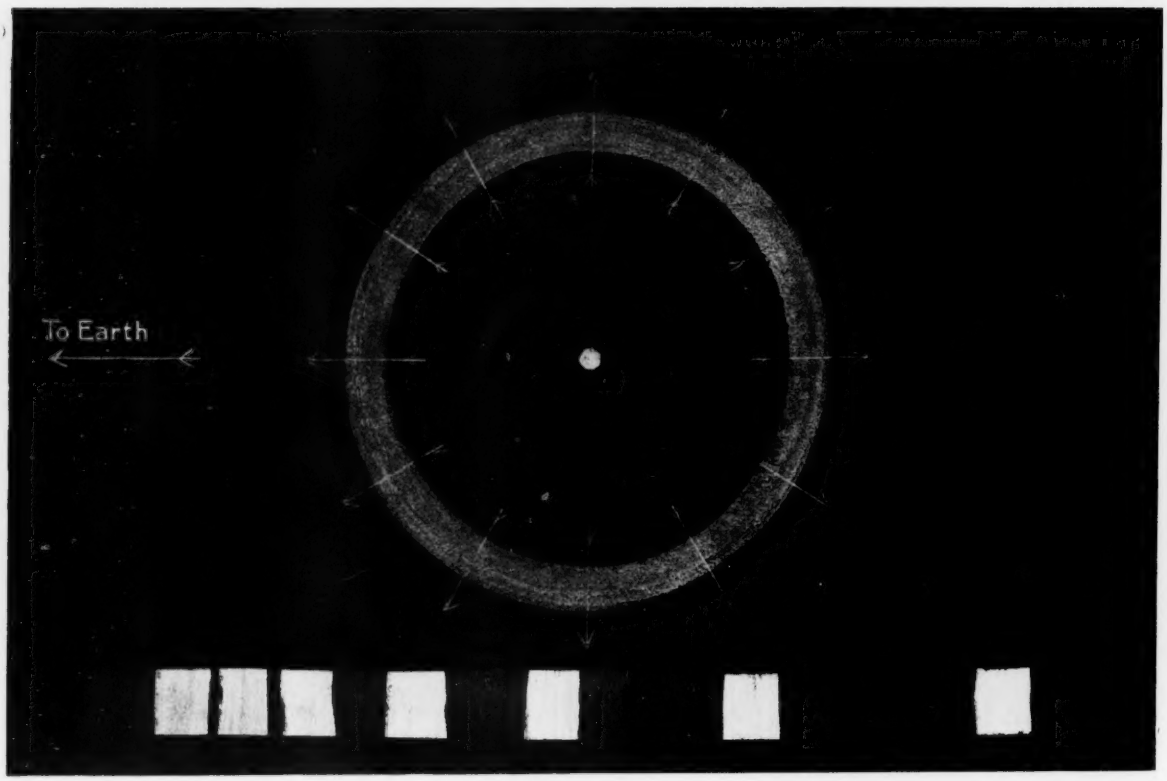

FIGURE 66.

body are moving in all directions the line broadens and becomes a band, even when we use a narrow slit. The width of a band does not indicate the distance travelled by an atom, it only shows its maximum speed. The atmosphere of a star that produces broad bands may have no convection currents; the atoms may simply be vibrating, due to heat. The average width of the bands of many pre-solar stars seems to indicate that the speed attained by the hydrogen atoms is something like two hundred miles a second each way. In Nova Persei the displacement of the black band and the widening of the bright bands indicated a speed of about one thousand miles a second. The temperature varies as the square of the velocity. So, if the widening of the bands in this temporary star was originally due to heat, its temperature must have been about twenty-five times as high as that of a pre-solar star.

In my article on the Sun ("KNOWLEDGE," February, 1912) I showed that the photosphere was probably due to the mixed elements of the Sun having a definite surface of statical equilibrium. The fact that the spectra of pre-solar stars give black hydrogen bands shows that they have a photosphere shining through a cooler atmosphere and seems to suggest that these stars have the same structure. As it is easier to understand the bright lines of emission than the dark lines of absorption, so it is easier to understand the bright bands of hydrogen seen in novae than the dark bands of stars. We shall try to understand the bands of temporary stars before those of the Sirian stars.

THE BRIGHT BANDS OF NOVAE.

Novae, or temporary stars, are brilliant stars that appear suddenly in the heavens : at birth they may be some thousands of times the intensity of the Sun. They quickly increase in luminosity until in some cases they are scores of thousands of times more brilliant than our ruling orb. They then fade too rapidly for ordinary cooling to account for, and generally for a time become planetary nebulae.

In the past they have been the enigmas of astronomy, but the account of their origin given in "KNOWLEDGE" (September, 1911) agrees so absolutely with all their characters as to be a satisfactory explanation of their genesis.

Novae are the third stars torn from partially colliding suns. Stellar flint and steel have grazed each other, and struck off a cosmic spark of stupendous brilliancy and wide astronomic potentiality.

Wonderful as are the series of phenomena of novae, yet they are all so singularly alike as to be able to be divided into six criteria, any one of which is explained in every detail by the theory of the third star; and no other theory of their origin fully explains one of the six.

The new star has taken so much energy of the collision of its gigantic parents as to be an exploding sun. It possesses a curious tendency to sort its atoms, so that they tend to expand in a series of ensphering shells with the lightest element, hydrogen outside. Gaseous adhesion carries other elements with it to some extent. The speed of expansion of this shell is many times its critical velocity; that is, the gravitation of the new star will never stop the rapidly moving hydrogen atoms. As the phenomenon of novae is largely made up of the behaviour of hydrogen, we shall at first, for simplicity, treat of the bright bands of hydrogen alone. We shall take its black bands and other spectral phenomena after we have studied the phenomenon of reversion.

Let us imagine a vast shell of the luminous hydrogen expanding in all directions (see Figure 66). It is so far away that it appears to be a mere point of light. The ring represents a section of the expanding sphere of gas. It is of the character of a radial wind. Notice that the motion of expansion is molar motion, but there is also intense indiscriminate motion of heat that makes the atoms strike one another and produce an internal quiver that causes luminosity. In the vast expanding hollow spheres the atoms nearest us are advancing; the atoms on the far side are receding. Let us first study isolated groups of atoms (see Figure 64). Let E be the Earth and V–R the spectrum of a single overtone. A will be the atoms coming our way, B those receding; the atoms travelling right and left are not displaced, as they keep the same distance. A, coming directly towards us, is most displaced towards the violet; B, going away, is most displaced towards the red; C is resolved in our direction and displaced towards V, and D is resolved away and displaced towards R. So we have a series of lines. Fill in the intermediate spaces as in Figure 65, and then imagine the whole a radial mass of moving atoms, as they are, and the whole space becomes a band. Do the same for all the overtones as in Figure 66, and we have the exact effect of a late stage of all novae. Thus easily is explained the broad, bright bands of new stars. Explanations of every other detail of the extraordinary sequence of spectrograms that novae develop are fully explained as we trace the multiple phenomena of the complex third body struck from grazing stars or dead suns.

If the series of hydrogen bands of the stars of Secchi's first type is caused by heat, each atom is vibrating internally and producing the overtones, and also moving in all directions in a series of short, free paths. In the novae we saw the different atoms travelling in regular radial paths. In this case we have to imagine that each atom successively travels in all directions, and so displaces its lines on both sides of the normal position.

There is still another way in which lines may be broadened into bands, and that is, if a star were rapidly rotating and the equator were edge on to us, on one side the star is approaching, on the other it is retreating (see Figure 63); so the lines would broaden. But if this were the case with pre-solar

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stars there would be no thin lines, but these are seen beautifully in Figure 423 "KNOWLEDGE," Vol. XXXVI (November, 1913).

These thin, dark lines indicate comparatively cool gases in the outer region of the star's atmosphere; but of black absorption lines we shall treat in the next article.

Each of these three modes of the broadening of bands must be considered when trying to solve the problem of complex stars. We have hinted at quite intelligible solutions of some of the so-called "enigmas" of spectra, and we shall find that most others find solutions if only we attack them aright.

If we imagine an atom to be a kind of flying spherical bell that rings and vibrates when it is struck, and that some notes last some distance as the atom travels and others die out quickly, it will give an idea of the meaning of the long and short lines of the spectrum. If some elements in an electric arc or spark be focused so as to cover the exact length of the slit of a spectroscope, some lines reach across and some do not. Figure 61 shows the difference in this respect between the electric arc and the induction coil intensified by a Leyden jar. In these beautiful spectra the images have been thrown on the slit in a direction parallel to the flames, and in each case only one half has fallen on the slit, so that one of the poles shows along one edge of each spectrogram. All these spectra, but especially those from the spark-jar, show in a striking way the difference in the duration of the atomic overtones as seen in these long and short lines, some reaching from pole to pole, others only a small fraction of the distance. Although some of the lines of each element are the same in the two different spectra, yet, taking it all together, they show a great difference in the way the atom is disturbed when the vibrations are produced by the electric arc and by the tremendous shock of the spark-jar.

It is believed by some workers that some atoms are broken up by the shock of the condensed spark, and that some of the lines belong to the fragments; and the same fracture happens in many stars. This is a line of research that is worthy of much more patient work, although a good deal has already been done in this direction. What is now wanted is correlation between the wonderful revelations made by researches in radium phenomena and those made in connection with high-intensity spark spectra and spectrograms that show similar lines. We appear to be on the threshold of great and important revelations regarding the constitution of matter. It is clear that the problem has to be attacked both from the wide cosmic and the minute electron standpoint. It is certain we have higher temperatures and more stupendous forces at work in the crucibles of cosmic space than are possible in any laboratory experiments. Consequently the true interpretation of spectrograms is probably the most important scientific problem of the present day.

CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—Could you inform me why there is only one daily high tide at Freemantle instead of the usual two, or give me reference to a source from which I could get the required information?

W. GORNOLD, F.A.S.

SOUTH KENSINGTON, S.W.

GINKGO BILOBA.

To the Editors of "KNOWLEDGE."

SIRS,—My attention has just been drawn to the plate of *Ginkgo biloba* in the January issue of "KNOWLEDGE." The tree as represented in this plate has not the characteristic form, and can only be regarded as an imperfect and inferior specimen. There are two specimens at Cobham Hall, near Rochester, incomparably superior to the Kew specimen, and at least one-third larger. It is a tree which only attains its characteristic habit at a considerable age. The Cobham specimens are about a century old and present a noble aspect with semi-drooping habit and long branches sweeping the ground.

"HURSTCOT."

CHATHAM.

THE FREEZING OF WATER.

To the Editors of "KNOWLEDGE."

SIRS,—It is often asserted that, given two masses of water, the one at the higher initial temperature will freeze first. I am wondering if this theory is classed among popular fallacies.

At first sight, of course, the theory seems absurd. Water has its maximum density at 4° C and thus all the water in a pond must sink to this temperature before freezing. It follows that, in considering two ponds under equally exposed conditions, the subject might be discussed under three heads:

(1) Initial temperature of both ponds above 4° C.

(2) Initial temperature of one above 4°, but that of the other below.

(3) Initial temperature of both below 4° C.

With regard to case (1) it is only necessary to consider the conditions down to 4° C since below this temperature they must be the same for the reason stated above. The pond at the lower temperature of say 10° C, will take t hours to fall to 4° C, and the pond at say 30° C will take T hours to fall from 30° C to 10° C. In falling from 10° to 4° it will take presumably the same time as the other pond, *i.e.* t hours. Thus one pond occupies t hours and the other $(t + T)$ hours. Mean temperatures are referred to. If the theory is wrong where does the fallacy come in?

The above seems logical, but I have some evidence which certainly seems to bear out the first theory. A lake near Crediton, in Devonshire, narrows considerably in the middle, practically making two lakes. They are not very exposed, being surrounded by trees; but one lake is fed by a hot spring: this lake is always *the first to freeze in winter.*

I should be very glad to hear the opinions of your readers on this point.

C. H. E. RIDPATH.

210, ADELAIDE ROAD,
SOUTH HAMPSTEAD.

MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

The question of utilising museums in education is not a new one, but the success which has attended the appointment of guide-demonstrators in some of our National Institutions and the fact that there is a Committee of the British Association considering the matter make it one of interest at the present moment.

Lord Sudeley is the great advocate of using museums to a larger extent, and in a recent address which he gave he had a good deal to say with regard to the taking of children to museums. A point worthy of consideration is whether the collections shown in our great institutions are meant for the use of children; and although they may be very valuable, nevertheless, in the absence of anything else, might it not be even a better plan to have museums, or at least exhibits, which are arranged and intended for young people?

There are a number of practical details which should come in for consideration. There is the height of the cases, the amount of material displayed, the wording of the labels, not to mention the particular specimens which might be specially chosen with a view to exciting the interest of children.

Now in utilising museums in general education it is possible, as has already been said, to prepare special exhibits for young people which could be kept in a children's room, set apart for the purpose, in existing institutions; or museums could be inaugurated especially for children; while in the third place—and this becomes almost a necessity in great cities—the museum could be taken to the child by having a series of specimens which travel the round of the schools.

The whole subject is one which must be approached in a broad spirit. It is not one with which the curator alone should deal; he may be in a groove and know nothing of teaching. The educationist might offer useful suggestions; the teacher could give information about the capacity and needs of his pupils; and it would be well not to ignore the advantage of having someone to write the labels who knows how to put the matter before people in print, so that they may be tempted to read it. The present writer has taken some interest in education, especially where things rather than books are concerned; he has been a schoolmaster, is acting as a museum curator, and at one time earned his living by writing for the Press. He has therefore been tempted to make some remarks in regard to museums as aids to teaching and to put down on paper some ideas with regard to the planning-out of a children's museum.

Turning first of all to the question of a demonstration in the case of existing collections. The first requirement of the guide is that he should know the museum thoroughly. He should be aware of the reason why each specimen has been chosen and all that it shows. In a small institution it might be possible for the curator or one of his assistants to do the demonstrating, and nothing could be better than that the man who carried out the work should explain it. Unfortunately many museums are very much understaffed. In larger institutions guide-demonstrators would devote their whole time to describing the collections, and would be chosen for their wide knowledge. It is quite possible, though we do not think it is the ideal arrangement, for the children's own teacher to take them round the museum. We can see the advantage if the object of the visit be to illustrate some particular lesson which the teacher has given or has in mind, and he can judge better the capacity of his pupils to benefit by what they hear and see. One cannot help thinking, however, that it is an advantage for children to be taught occasionally by someone to whom they are not accustomed, and to come into contact with another personality. The teacher should always be at hand, so that reference can be made to him or to her, and discipline, if necessary, be maintained.

It is all very well to say that museums are not as useful as they might be, but we have to remember the objects which they fulfil, quite apart from the question at issue. We take it that, first of all, a museum is to educate those members of the general public who feel inclined to take advantage of it. It fills the place of a textbook, more or less simple, in which the pictures are replaced by the things themselves. A great advantage is that it preserves many objects which would otherwise be lost, or scattered about in private collections—where they could not be severally seen—things that are no longer used, animals which have become extinct, and so on, as the case may be. To be of any great value or importance a museum should be a place of reference, though the collections intended for scientific students and specialists need not be displayed. Works of art, however, will generally be on view, though we are all familiar with the arrangements whereby galleries of pictures and sculpture may be closed to the public on students' days.

We may return now for a moment to the personal explanation of the contents of museums. Just as it would be possible for a very pleasing lecture or a most attractive article to be culled from a textbook, so the guide-demonstrator can tell a story about the specimens which arouses interest, and even enthusiasm, on the part of his hearers. For this

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reason the appointment of such an official in all public institutions is most strongly to be urged.

It is not, however, the bigger museums that we wish particularly to consider here. The collections contained in them are so extensive that our remarks would hardly apply to them except as regards a room specially arranged for children, should one be instituted. We are fully aware of the difficulty of adapting old institutions to new purposes, and we would prefer to discuss the formation of a small museum intended to be educational in the best sense of the word.

To begin with we shall leave on one side art and history and deal with the natural environment of the child; but before going into detail it will be necessary to emphasise the point that, if it is to be thoroughly successful, a museum of whatsoever kind must be made to *appear*, as well as to *be*, interesting. Moreover, it is just as important that what is on view should attract, not only during the first or second visit, but also on any subsequent occasion. If the museum is to be for children it is imperative to have exhibits which appeal to them. Care should be taken that there be no overcrowding of specimens, and that there be not too much in one place to be appreciated at any one time, while it must not be forgotten that the cases should be of a height suitable to the stature of the visitors for whom the exhibits within are intended.

In the case of a small museum, if interest is to be sustained, the only plan seems to be to introduce a very definite system of changing what is on view. At this point it may be mentioned that it is now becoming recognised that there is no necessity for everything in a museum to be dead. Already, in a number of modern institutions, there is a living side, even if it only amounts to a series of the common wild flowers which are to be found in bloom during the month. Here we find introduced at the same time a specially attractive feature and the element of change. A very good suggestion recently made during a discussion at the Birmingham Meeting of the British Association was that specimens should be provided which the visitors could actually handle. This, again, would be an additional source of interest, though care would have to be taken to choose material which could not easily be damaged, or at any rate be replaced without any difficulty. It has occurred to the present writer that it would be interesting to him and possibly useful to others if he were to show, by actual exhibits, his idea of what a children's museum should be. He therefore suggested to the promoters of the Children's Welfare Exhibition that space might be found at their Exhibition for "A Children's Museum." As they agreed to the suggestion, the exhibits are being prepared, and a scheme is given here showing what it is intended to illustrate as a whole or in part.

Nowadays, when speaking of teaching, particularly in connection with natural objects, it is advisable to differentiate between that which is didactic, and is concerned with the giving of information to the pupil, and that typified by Nature Study (using the words in a technical sense), which leads the pupil to acquire knowledge as a result of his own observations. At first sight, as ideal Nature Study is carried on out of doors in natural surroundings, wonder might be expressed as to what part in such work the museum could play. It has all along been recognised during the Nature Study movement that it is not always possible to be in the field—there are some observations which can be made under a roof which would not be possible or most difficult to carry out in the open—and that the watching of animals in aquaria and vivaria, in observatory bee-hives, and artificial ants' nests may supplement and may even prove a fair substitute for outdoor observations. It is, then, to the living side of the Children's Museum that we must turn in this connection, though, as we shall see, it may be brought in with much effect in regard to other work.

Even preserved specimens may have a value in Nature Study. They may be records of work which has been done; they may illustrate, for instance, the life-histories of insects that have been reared by the pupils in the case of a school museum; or they may be collections made on rambles, illustrating some particular habits of plants or animals. If they have been mounted and described by the scholars themselves in proper museum style it will have given them some training of a kind which is not easily equalled; for not only will they have had to make the original observations, but also to exercise more or less skill in manipulation, neatness, and a considerable amount of good taste, as well as to write a description in a brief and clear manner.

Reverting to our suggestion that changes should be made in the museum where it is small, and bearing in mind that there is very little room available for school collections, as well as that the making of them is an important point in Nature Study, we would suggest that Nature Study records should be continually replaced. The old exhibits can be afterwards passed on to classes to which didactic lessons are given, and, though possibly being put on exhibition in another section of the museum from time to time, may be kept stored away to be brought out when required.

In a public museum preserved specimens may very usefully suggest series of observations that can be made, and if the objects be seasonable the changing of them will be a natural sequence. We shall expect to see methods of seed dispersal shown in the late summer, and fruits opened by birds and beasts for their living, during the late autumn and winter, while there may be other series which will give a hint as to work that can be carried on at any time. Further details may be looked for in a list of suggested series that we shall give later.

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Turning now to the didactic side, we shall find that living animals may, equally well with the dead ones, give an idea of forms that can be met with in the neighbourhood and elsewhere, so that some knowledge of classification may be gained.

From the aquaria, minute forms of life can be obtained, and microscopes should be at hand for their examination. Unicellular and filamentous plants can just as easily be studied as Protozoa. Sponges may not be easy things to keep. Hydra, though not typical of the Hydrozoa, may serve to illustrate the group Coelenterata, and there is a colonial freshwater form (*Cordylophora*). Among marine creatures some forms of sea-anemones will thrive well in inland salt-water aquaria, and to the ocean we must go for any representative of the Echinodermata. The common starfish, or five-finger, will often live for a considerable time in captivity. Many representatives of the Vermes—threadworms, rotifers, leeches—live in freshwater, as do Crustacea, and certain insects and water-spiders among the Arthropods. Some of the most beautiful of microscopic animals are the freshwater Polyzoa, and the Mollusca are well represented. Other insects in the caterpillar stage will be reared in breeding cages on their special food plants. Observatory hives and ants' nests have already been specially mentioned. Land Molluscs will occupy vivaria. In aquaria, again, will be the fish, the early stages of the frog; adult amphibians, and the reptiles will need vivaria. Animals higher in the scale are not so convenient to deal with in a museum, but if birds are not to be kept in cages then it may be possible to get some of the wild ones to come to the windows for food, and at the right time of year observatory nesting boxes could be placed inside the children's museum (with the entrance opening to the outside), so that the birds could be watched when building their nests.

In the case of mammals, such tiny forms as the harvest mouse might be shown. It would be advisable to choose, so far as is possible, common British animals, but occasionally, when opportunity offers, some interesting creatures from abroad might be introduced.

It may not be necessary to say anything about the necessity of labelling aquaria, but it is advisable to urge that one kind, or at the outside two or three kinds, of animals, should be kept in a single tank. Sketches of the inmates and of the various weeds growing in the water would help to make matters clear.

The actual receptacles that can advantageously be used will, if possible, be described later, with the methods recommended for exhibiting ordinary museum specimens. It may be said, however, that, whenever possible, glass-topped boxes of uniform dimensions, or multiples of a particular size, should be adopted for the following reasons among others:—

(1) The specimen when once mounted is kept clean and preserved from injury, and is not easily divorced from its label, which also is not allowed to become dirty.

(2) Series can be arranged in orderly sequence and easily displayed.

(3) Fresh boxes can be introduced anywhere with the minimum of difficulty.

(4) The specimens can be conveniently carried about and passed round a class.

In planning out the collections of specimens which are not alive, the question of space will have to be considered, and also the particular object that the museum is expected to fulfil. A classificatory series may be arranged so as to go into very great detail. It may be sufficient to show a few salient points about mammals, for instance, or to illustrate the hair, teeth, skeleton, and structure of the class. In a school where biology is an important subject, all groups might be treated and the part of the collection bearing upon the work of the moment displayed for the time being in the museum. If everything be on view at once the museum can only be looked upon as a storehouse by those who have become familiar with its contents. It is true that one generation of scholars succeeds another, but each individual may remain at school for a number of years.

Collections illustrating habits should specially be mentioned, and series of specimens can be brought together illustrating subjects of general biological interest, such as variation, secondary sexual characters, hybridisation, and protective coloration.

A local museum should usually have for reference specimens of the common species of plants and animals found in the neighbourhood. These should be useful in identifying any doubtful find. It is to be hoped that enthusiasts in schools may have access to such collections, as it will often be beyond the scope of the school museum to have local series. It might, however, be useful if a school were to specialise in certain groups, and not take up everything that comes to hand. Here, again, though the series would usually be out of sight, it might not be amiss occasionally to attract attention to them by exhibiting them.

Very useful work has already been done by museums in preparing object lessons for their juvenile visitors. The work is not intended to take the place of independent nature study observations. They are lessons pure and simple, but made most interesting and valuable by the introduction of concrete examples of the things concerned.

Lastly, we may mention exhibits which are useful in showing what kinds of observations can be made out of doors by those who have the opportunity, and suggest the collecting and mounting of similar series on the part of those who see them.

(To be continued.)

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THE SCOTTISH ZOÖLOGICAL PARK.

By Dr. WILLIAM S. BRUCE, F.R.S.E.

(*Vice-President of the Zoölogical Society of Scotland.*)

Several attempts have been made to establish a zoölogical garden or park in Edinburgh, a movement in which Scottish zoölogists have been very keenly interested. None of these was successful, however, until a small body of zoölogists and laymen made a determined effort in 1910 and founded the Zoölogical Society of Scotland. These pioneers each paid an annual subscription and induced a few others to do the same. A practical start was made by the organisation of a few lectures on a small scale, and the exhibition at these lectures of living animals. These lectures and exhibitions were well attended, and every meeting brought more members—all enthusiasts in the cause—into the Society. The Society was then more definitely constituted, and elected a capable executive of business men and zoölogists. These were found especially in the persons of Lord Salvesen, Professor J. Cossar Ewart, Mr. Thomas B. Whitson, and Mr. T. H. Gillespie. A grant of £500 from the surplus of the Scottish National Exhibition (1909) Fund helped to put the young Society into the position of having at its back a small capital, and it was pleasing that a further small sum that had been lying on deposit receipt for forty years, the remnant of the funds of the old Edinburgh Zoölogical Garden, should have been transferred by its trustees to the new Society.

So successful were these early efforts that in the autumn of 1912 there were two hundred and fifty members of the Society, and one of the largest halls in the city had to be taken for the lectures which were now well attended by the general public. In the meantime quite a number of available sites were inspected, and the best expert advice was taken to determine which should be ultimately chosen.

An estate on the well-wooded slopes of Corstorphine Hill was chosen, and an appeal issued for funds for purchase and equipment; £12,500 was quickly raised, and the Town Council of Edinburgh, at the request of the Society, bought the site, consisting of a mansion and seventy-four acres of ground, and feued the property to the Society for the purpose of a zoölogical park.

The work of laying out the Scottish Zoölogical Park was begun in April, 1913.

The site is divided into two portions. The southern portion consists of a mansion house with gardens, shrubberies, and parks surrounding it, and comprising twenty-seven acres: this is the portion at present being developed. The other portion, extending to forty-seven acres, is reserved for future extension, and will provide magnificent ranges for buffaloes, deer, antelope, sheep, and goats. The site is on the southern slope of Corstorphine Hill: it has abundance of growing timber and rock, and has been characterised by experts who have inspected it as one of the finest and most beautiful sites in the world for the purpose of a zoölogical park. When completed the Scottish Zoölogical Park will probably be unsurpassed by any existing zoölogical park or garden.

Gratifying as were the early efforts of the promoters, they have been still more so since the opening of the Park to the public on July 22nd, 1913, for no less than one hundred thousand people visited the Park, and the excess of revenue (excluding Fellows' annual subscriptions) amounted, during three and a half months, to a sum not far short of £1000.

Heavy outlays up to date have been made on roads, fencing, laying of watercourses and drains, construction of water-fowl ponds, dens for polar bears, lions, leopards, and other carnivora; aviaries, monkey-house, bandstand, refreshment rooms, and lavatories. There is an excellent polar-bear den and pool (see Figure 68) in which there are two polar bears and two brown bears. It is blasted out of the whinstone rock, and thus the rock scenery is not artificial, but is actually the natural rock *in situ*. Spacious as is the pool already, it will ultimately be double its present size. Here both polar and brown bears disport themselves, and are seen to great advantage in their actual surroundings with no barrier between them and the visitors except a handrail on the crest of a vertical cliff of rock, up which the animals are not able to climb, rising out of the water. Two similar dens, hewn out of the natural rock, are at present being constructed for the lions and for the leopards: these are nearing completion. These dens are being constructed on the lines of Hagenbeck's dens. The lions' den will be fifty-five feet long, bounded at the back and ends by an overhanging cliff, and in front by a deep trench across which the animals cannot pass. The den is so arranged that it presents a succession of excellent views to visitors as they ascend the walks.

So far three ponds have been constructed for water-fowl (see Figures 70, 72 and 73), and these and the bear pool form at present leading features of the enclosures. Each pond has its own attractions, and along with the bear pool give an idea of what the Council of the Scottish Society are aiming at, namely, to have animals exhibited in comfortable quarters as nearly as possible resembling their native habitat.

One of the first enclosures one meets with on entering the Park is that of the bison. It is a large paddock, surrounded by a low fence of fir poles, with an inner ditch which prevents the bison from charging the fence. Near it is the foreign water-bird pond, and rising up the hill one comes to other

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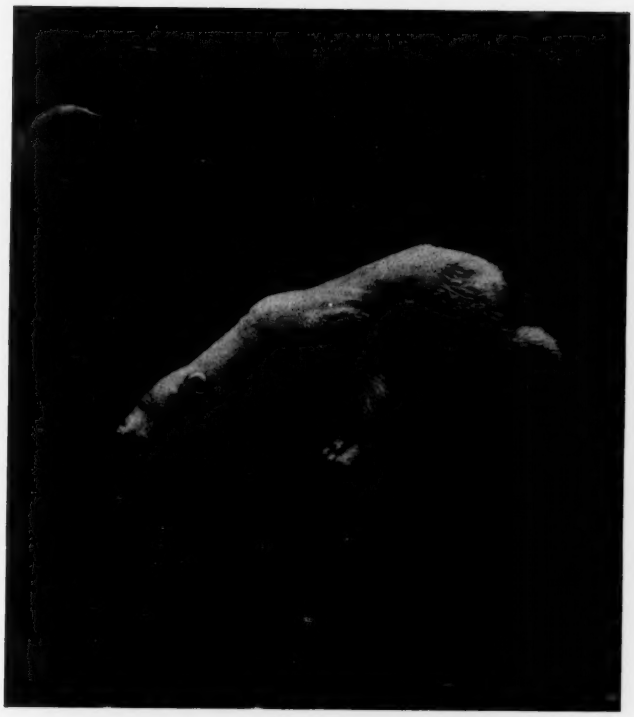

FIGURE 67. Polar Bears drinking and swimming.

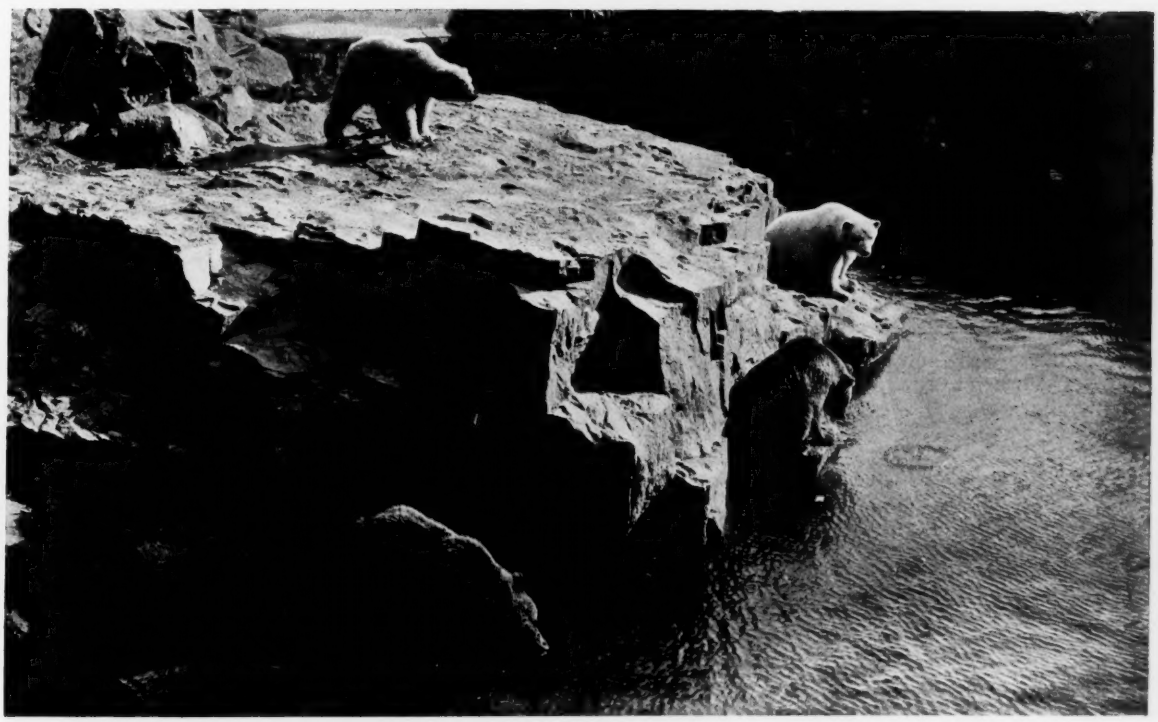

FIGURE 68. Polar Bears and Brown Bears in the Bear Pool.

From photographs by J. C. McKechnie.

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FIGURE 69. Terns.

FIGURE 72. The King Penguins.

FIGURE 70. The Crane Pond.

FIGURE 73. View showing one of the Bird Ponds.

FIGURE 71. The Hyena.

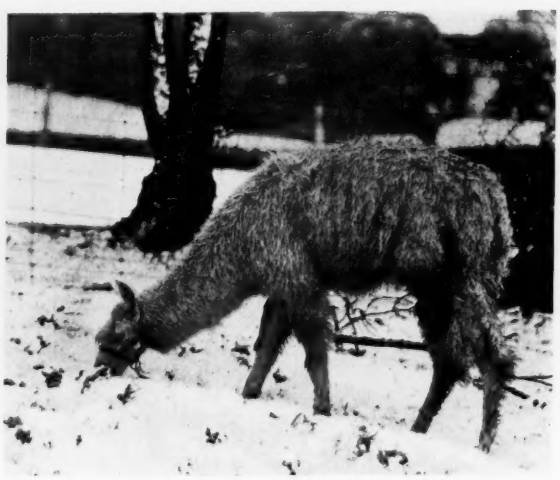

FIGURE 74. The Llama in snowy weather.

From photographs by J. C. McKechnie.

pools and ponds, mostly alongside the main winding pathway. All these pools are supplied from natural springs, and the existence of these was all along to be one of the leading features of any ground the Society meant to acquire in order to save a heavy water bill. These springs are not likely to fail, as the Society's Park extends beyond the summit of the crest.

One of the difficulties has been to induce people to believe that animals such as lions could exist in Edinburgh during the winter, a fallacy it was very hard to kill, in spite of much expert evidence to the contrary. As a matter of fact, the climate of Edinburgh is a very equable one, having neither the extreme heat nor cold of either Hamburg or New York, where excellent zoölogical gardens exist.

During the New Year holidays there has been a good trial, because there has been an exceptionally cold spell, with rather rapid changes. Snow has fallen quite considerably, and then quite sharp frost for this part of the world has followed, and none of the animals appear to have suffered in any way. The animals, provided with dry and sheltered sleeping accommodation, appear to be amenable to the outdoor life to which they have been subjected. The monkey-house, part of which has been built, is, for instance, an entirely out-of-door structure, as is also the large parrot aviary, and the lions and other large carnivora also live almost entirely in the open.

The Society aims at having a representative series of animals, and already the collection—partly purchased, partly loaned, and to a large extent generously given—is well worth visiting.

The Dublin Society has gifted a fine pair of lions, while Lord Pentland, till lately Secretary for Scotland, has secured an elephant, through the generosity of the Maharajah of Mysore; and, last, but not least, a most interesting series of Antarctic animals has arrived, having been presented to the Society by Messrs. Salvesen, of Leith. This series includes two young sea-elephant seals, a young Weddell seal, and six penguins of three species. Southern Sea elephants (*Macrorhinus elephantinus*) have never been seen alive north of the Equator, and it will be very interesting to watch the development of this pair of healthy animals that have been transported seven thousand miles to their new home. The habitat of the sea elephant is in sub-Antarctic seas, both Atlantic and Pacific, south of the latitude of 40° S. The Weddell seal (*Leptonychotes weddelli*) is even more interesting than the sea elephants, because it is a true Antarctic species, and has certainly never been exhibited in any zoölogical garden in the world; moreover, the type specimen is housed in the Royal Scottish Museum, and has been described by Professor Jamieson, of the University of Edinburgh. The Weddell seal is a typical shore seal of the Antarctic regions, being found in shallow water off the coasts. The penguins are also interesting: four of them are king penguins (*Aptendytes pennauti*), which have been exhibited before in the Zoölogical Gardens of London, as well as in other places; but it is probably quite a new feature to have two of these interesting birds in the down stage. The second species of penguins secured is the gentoo penguin (*Pygoscelis papua*), which has been rarely seen in European zoölogical gardens, although recently there has been one in the Zoölogical Garden of London. The third, the macaroni penguin (*Catarrhactes chrysolophus*), with its beautiful golden crest, possibly constitutes another European and American record in being exhibited in a zoölogical garden. Like the seals, these penguins have taken very kindly to their new home. They were all taken in the interesting island of South Georgia, which has recently become a great centre of the whaling industry, and they form an interesting and important contribution to the collections of the Zoölogical Society of Scotland.

THE ZOÖLOGICAL SOCIETY OF LONDON.

AT the meeting of the Zoölogical Society held on February 17th, Mr. E. G. Boulenger, F.Z.S., Curator of Reptiles, exhibited a photograph of a female example of the Giant Saddle-backed Tortoise (*Testudo abingdonii*) recently purchased by the Society. On the arrival of the tortoise, the origin of which was unknown, Mr. Boulenger was somewhat puzzled as to the species to which it should be referred, but, on carefully comparing it with the Saddle-backed Tortoise in the British Museum, came to the conclusion that the specimen was none other than the hitherto-unknown female of *T. abingdonii*, a species which had never previously been brought to Europe alive, and which was thought to be extinct. An inspection of the very representative collection of Giant Tortoises in the Tring Museum strengthened the conclusion arrived at.

From the few male specimens in museums, this Tortoise differs by the fore-part of the shell being less strongly compressed and not reaching the same height, more as in *T. ephipium*, by the comparatively greater breadth of the hinder part of the carapace, by the broader bridge, and by the smaller size of the marginals bordering the bridge

Mr. Boulenger also remarked upon some of the habits of this species. Among the papers read was one by Professor F. Wood-Jones, on some phases in the reproductive history of the female Mole (*Talpa europea*). He dealt with the nature-lore connected with the sexual evolution of the Mole, the embryological development of the reproductive system, seasonal changes in the external sexual characters of the adult female, and the character of these changes as seen in microscopical sections of embryos, nestlings, and adults.

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METEORIC ASTRONOMY.

By W. F. DENNING, F.R.A.S.

DURING the last few years meteoric astronomy has been spoken of in rather flippant terms by certain individuals. I do not think that any astronomer of high standing has disparaged this branch, but there are certain others who apparently fail to discern its importance, who are sceptical in regard to its theories, and who question the accuracy of the observations.

But, in spite of opposition, the department of astronomy dealing with meteors will continue to hold an important position because its teachings are widespread and significant. The structure raised by Coulvier-Gravier, Heis, Schmidt, Lowe, Schiaparelli, H. A. Newton, A. S. Herschel, and others will stand and flourish amid the increasing knowledge of succeeding ages.

In the few past years there has been unusual activity apparent in several lines of astronomical research; a number of large volumes have been published containing an immense amount of observational data concerning variable stars. Very little has been printed about meteors save a few small pamphlets or papers in scientific journals. Yet meteors are the connecting links between our Earth and other worlds. Millions of them are consumed in our atmosphere every day, and they are the only celestial bodies which we may view from a near standpoint, and submit to microscopical analyses.

They are also sometimes the most beautiful objects which the heavens present. To witness, on a clear starlight night, the slow, majestic flight of a fireball across the firmament affords a spectacle of unique grandeur. A richly coloured sunset supplies a magnificent scene; the sight of a new star, such as Nova Persei in February, 1901, is deeply impressive from its mystery, and the immense conflagration of which it is the distant emblem; but these things lack the transient glories of the meteoric fireball, which can bring day amidst the darkest night, and have been known to outshine the dazzling lustre of the Sun.

Misapprehensions, sometimes the outcome of a lack of knowledge, have caused certain people to neglect the study of meteors. The photographic method is thought to be the only accurate way of recording meteor paths, or of correctly fixing meteoric radiants. This is a great mistake. If a radiant were a point formed by the perfectly symmetrical convergence of meteors, then photo-trails, if they could be got, might indicate its place to the hundredth part of a degree. But a radiant is sometimes an area of several degrees; the Andromedid shower of November 27th, 1885, had a radiant spread certainly over more than seven degrees, and probably over more than ten degrees. Now, if one hundred meteors were photographed, and one hundred recorded by a good observer, the degree of accuracy would not be greatly in favour of the former, because certain parts of the area must give undue radiation at various times, and there might be a preponderance from one side just when the photograph was taken. Again, there are meteors which may cross one radiant and belong to another; and the exact place of a radiant varies from hour to hour owing to zenithal attraction and to other causes. Every meteor path, in fact, ought to have corrections applied to it.

For a single meteor, the photo-plate supplies a splendid record. Even the little variations of light along the path are distinctly shown, and I must say that it affords great satisfaction to work on the basis of such a record. But a good naked-eye observation need not be more than half a degree out in the direction at the assumed beginning and end points of a meteor, and the radiant point of a well-observed shower may often be derived within one degree.

When we consider the *area* of radiants, and the fact that the wrong meteors are sometimes applied to showers, we can easily see that a radiant determined by photography may be little more reliable than one formed by naked-eye estimates, and for the moment I am giving undue powers to the camera, for it has been found ineffective to gather a sufficient number of trails for fixing radiant points. Bright meteors are the only ones impressed on the plates, and for general purposes of meteoric record the photographic method has been a failure. While a man is occupied in getting a good meteoric photograph he could probably secure the observation of one thousand by the unaided eye.

I am convinced that the errors usually applied to meteoric observation are immensely overrated when applied to the case of an experienced and really capable man. If we regard many newspaper reports of meteors and records by casual observers as fair criteria, then the observations are wild indeed and deserve to be disregarded. Even by observers otherwise skilled in astronomical work a meteor's flight is sometimes terribly perverted, and makes confusion worse confounded when the computer endeavours properly to reduce the observations.

When, however, two good observers witness a meteor, and calmly record the essential features of its display, the height at appearance and disappearance can be worked out with a probable

error limited to two or three miles, and the radiant-point assigned to within two degrees and sometimes less.

If a man be peculiarly fitted by certain natural talents for the observation of meteors, it is astonishing to what accuracy he can attain after considerable practice. Having examined the results of many observers and made comparisons, I can confidently assert that the estimated eye observations are often very exact and trustworthy. We may turn to other departments where eye estimates have to be relied upon, and are even more correct. The magnitudes of variable stars are often thus recorded, with a little help from binoculars or ordinary telescopes; and transit times of spots on the telescopic disc of Jupiter are quite as well made by the eye as by micrometric measurement. There is no reason why the eye registration of meteor flights should not be made accurate in a degree scarcely thought practicable. They can never, of course, be made so beautifully true to nature as the photographic picture, but they can be obtained correctly to within an almost inappreciable extent in the line representing their *direction*, and this is really the important feature for ascertaining the radiants. For finding the lengths of paths and deducing the heights of beginning and ending we require great accuracy in other features as well as the *directions*. For myself I have always endeavoured to get the latter element as correctly as possible, for without it it is impossible to find reliable centres of radiation.

Nearly fifty years ago the observations of certain showers, such as the Leonids and Perseids, had been made with sufficient accuracy to prove that they radiated from the same points as periodical comets, and the great showers of 1866, 1867, 1868, and 1872 served to attract general attention to the subject of meteors; but since 1885 the lack of great displays and the want of any new cometary associations have served to bring about a decline of interest. Many things happened in the period between 1866-1872 to boom meteoric astronomy, and our knowledge exhibited rapid developments. Its progress has naturally been slower since, though many useful facts have been accumulating. We may look forward to another active period in this branch when past observations will be properly assembled and assorted. Our theories may require some little amendment, but the practical identity of comets and meteors will stand the test of further investigation.

The claims of meteoric astronomy need no enforcing from me. The names of the astronomers previously given who have been actively engaged in its study are sufficient to impress anyone both with the attractiveness and the importance of this branch. In this paper I have simply endeavoured to point out a few facts which seem to be scarcely sufficiently recognised.

NAPIER TERCENTENARY CELEBRATION, JULY, 1914.

JOHN NAPIER'S "Logarithmorum Canonis Mirifici Descriptio" was published in 1614; and it is proposed to celebrate the tercentenary of this great event in the history of mathematics by a Congress, to be held in Edinburgh on Friday, July 24th, 1914, and following days.

The President and Council of the Royal Society of Edinburgh have now the honour of giving a general invitation to mathematicians and others interested in this coming celebration.

The celebration will be opened on the Friday with an inaugural address by Lord of Appeal Sir J. Fletcher Moulton, F.R.S., LL.D. (Edin.), and so on, followed by a reception given by the Right Honourable the Lord Provost, Magistrates and Council of the City of Edinburgh. On the Saturday and Monday the historical and present practice of computation and other developments closely connected with Napier's discoveries and inventions will be discussed.

Merchiston Castle, the residence of Napier, has long been occupied by the well-known public school, which draws pupils from all parts of the British Empire. The Governors of the school have kindly invited the members of the Congress to visit the Castle and grounds on the Saturday afternoon.

Relics of Napier, collected by Lord Napier and Ettrick and other representatives of the family, will also be on view; and it is intended to bring together for exhibition books of tables and forms of calculating machines, which are natural developments of the great advance made by Napier.

Individuals, Societies, Universities, Public Libraries, and so on, may become founder members on payment of a minimum subscription of £2; and each founder member will receive a copy of the Memorial Volume, which will contain addresses and papers read before the Congress, and other material of historic and scientific value. It is important to secure as many founder members as possible, so that a volume may be brought out worthy of the memory of Napier.

Subscriptions and donations should be sent to the Honorary Treasurer, Mr. Adam Tait, Royal Bank of Scotland, St. Andrew Square, Edinburgh.

All who are interested in this proposed celebration are respectfully invited to communicate with the General Secretary of the Royal Society of Edinburgh, 22, George Street, Edinburgh, and to announce their intention of being present.

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SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(With illustrations from photographs by the writer.)

THE fungi are probably the most prolific of all living organisms. An average-sized mushroom will produce as many as eighteen hundred million spores, and a common toadstool Shaggy Caps (*Coprinus comatus*), which grows in fields and on rubbish, has been shown to produce as many as five thousand millions. Fortunately for the other inhabitants of the world, however, the probability of germination and successful growth of any given spore is somewhat remote. The mushroom or toadstool plant is formed by fine filamentous threads which ramify beneath the soil ; and, if we assume that a successful plant of the mushroom or Shaggy Caps produces as many as ten mushrooms or toadstools, we find that the chance against successful germination and growth to maturity of any given spore is respectively about eighteen thousand millions and fifty thousand millions to one in the two species mentioned. But even more prolific than the mushrooms and toadstools proper is the Giant Puffball (*Calvatia gigantea*) (see Figure 75), a large specimen of which has been known to produce as many as seven million million spores. Shaggy Caps—the toadstool just mentioned—rarely takes more than about twenty-four to forty-eight hours to shed its spores, and at the end of this time has dissolved into an inky mass. The mushroom also rarely resists decay more than a few days, but there are woody fungi which persist for years, and some of them go on shedding their spores for a very considerable period. *Polyporus squamosus* (see Figure 76), which produces shelf-like fruit bodies from the trunks of trees, has been observed to shed its spores continuously for as long as thirteen days. It has been calculated that as many as a hundred thousand million spores will be thus produced from a single fruit body of this fungus in one year. I myself have watched the spores falling from another very common toadstool, *Polystictus versicolor* (see Figure 78), at intervals for three days, and personal observation of the continual stream of spores given off by any of these fungi will give one a more readily appreciated idea of the vast quantity produced than any number of figures.

No more interesting demonstration can be imagined than that of the fall of spores from a fungus by the beam of light method. For this purpose any ordinary toadstool may be used, but many of the woody forms have this great advantage, that they can be kept dry for months or years, and yet, when moistened by water being poured on their upper surface, they swell out, and in a few hours begin to produce spores again. Specimens of *Lenzites betulina* or of *Polystictus versicolor* (see Figure 78), the commonest of our woody forms, are specially useful for this purpose. The toadstool is nailed, gills or pores downwards, on to a piece of wood. This forms the cover of a large beaker—the larger the better. A room which can be darkened, a long extension lantern and a lens of three or four inches in diameter, are also required. A lantern with an ordinary incandescent gas or electric lamp does fairly well, but limelight or a small hand-fed arc lamp is, of course, better. Where the lantern has not a long extension the front lens can be carried forward by a short cardboard tube. In this way a nearly parallel beam of light is produced, which is concentrated still further by means of the lens mentioned above. The beaker, placed close to the lens, is raised or lowered till the beam of light passes immediately below the fruit body of the fungus. With a white-spored toadstool something like a miniature snowstorm now appears from the fall of a million spores a minute if the toadstool is a large one ; and the warmth of the beam of light or of the observer's body, conducted through the glass of the beaker, produces cross-currents and eddies which seem to turn the snowstorm into a regular blizzard. The demonstration can be made even more striking if the cover of the beaker with the fungus attached be occasionally removed, and the interior temporarily cleared of spores by blowing into it from the mouth. When the cover and attached fungus are again replaced the commencement of spore-fall is especially striking.

When we consider the large number of spores produced by most members of the fungus tribe, it is a little surprising that any special devices for their distribution have been developed. We might have supposed that if left alone a sufficient proportion of them would be sure to find a suitable location for germination and growth. But it is important to the parent plant to have its progeny as far removed from it as possible, and therefore various methods of spore dispersal have been evolved. Indeed the whole structure of the greater number of the larger fungi will show how excellently they are adapted for the distribution of their spores. It is curious to note how closely the methods of spore dispersal in the larger fungi resemble those of seed dispersal in the higher plants. Arrangements for spore dispersal by the agency of animals, insects, and the wind are all seen, and a few fungi

FIGURE 75. The Giant Puffball (*Calvatia gigantea*). One of the largest of British Fungi.

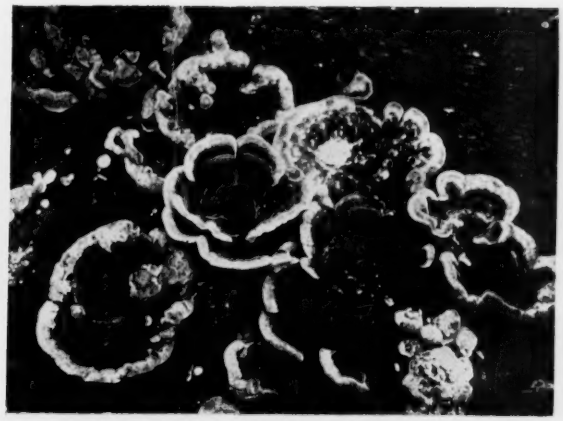

FIGURE 78. *Polystictus versicolor*. The commonest of woody Fungi.

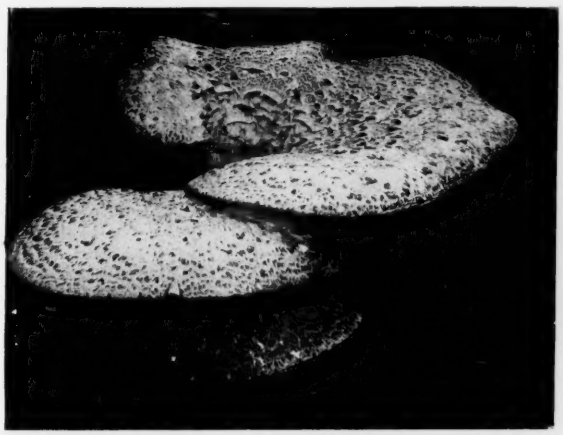

FIGURE 76. Dryad's Saddle (*Polyporus squamosus*). A common shelf-like form which grows on trees.

FIGURE 79. The Beech Tuft (*Armillaria mucida*), growing from the bark of a living beech tree.

FIGURE 77. The Stump Tuft (*Armillaria mellea*). A large clump of toadstools with the white spores all around.

FIGURE 80. *Helvella crispa*. A common British Ascomycete.

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FIGURE 81. *Helvella lacemosa.* A form in which "puffing" may be observed.

FIGURE 82. *Stropharia squamosa.* A form with a long stalk which raises the cap well above the ground.

FIGURE 83. The Common Morel. *Morchella esculenta.*

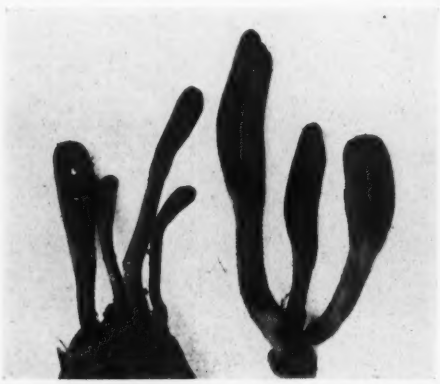

FIGURE 84. *Mitrula viride.* An Ascomycete with a club-like form.

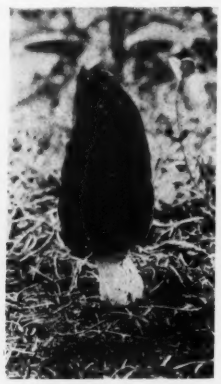

FIGURE 85. *Morchella conica.* A pretty little Morel appearing in summer.

FIGURE 86. *Peziza badia.* A cup-shaped Ascomycete.

FIGURE 87. *Bulgaria inquinans.* An Ascomycete with a spore-bearing surface which is nearly flat. It grows on trees.

FIGURE 88. *Sepultaria coronaria.* A fungus which comes up in spring. Its inner spore-bearing surface is protected in the early stages of its development.

shoot their spores to long distances in the same way that the Broom and other plants shoot out their seeds. It will thus be seen that very similar methods of seed and spore dispersal are found in both fungi and flowering plants, but there is this difference, that the spores of fungi are so much lighter than most of the seeds of flowering plants that a larger proportion—indeed, many of the most highly developed members of the class—make use of the wind for the distribution of their spores, and practically the whole of the toadstools proper—that is, fungi with an umbrella-like form—have their spores distributed in this way.

If we take a mature mushroom or toadstool of any sort, and, breaking off its stalk, lay it, pores or gills downward, on a piece of paper beneath a cover for, say, twelve or twenty-four hours, and then carefully remove it, a more or less perfect map of the lower surface of the cap will be seen. This toadstool *autograph*, as it may be called, is produced by falling spores, and is easily seen in the dark-spored varieties. But where the spores are pink or white it may not be noticed if ordinary white paper be used; it is therefore preferable to use a piece of printed paper instead.* In nature it is unusual to find any visible mass of spores on the ground beneath toadstools growing singly or in small groups. Where toadstools form large masses, the spores from the higher are sometimes found deposited on the caps of the lower as well as all around them. On ground surrounding a large clump of the Stump Tuft (*Armillaria mellea*) (see Figure 77), for instance, an appearance almost like that of mildew may sometimes be seen produced by myriads of small white spores; so thickly are the spores deposited indeed that one cannot help doubting whether such large clumps of toadstools are as efficient for purposes of spore dispersal as a number of small tufts.

Although a vast number of spores are produced by most fungi, a sufficient number to be visible to the unaided eye is the exception rather than the rule, and the two main factors which are responsible for this are the very constant presence in the larger fungi of a sterile stalk (see Figure 82), which raises the spore-producing area an appreciable distance above the level of the ground, and the existence of air currents close to the ground. It has been shown that in perfectly still air spores take an appreciable time to fall from the gills to the ground. This varies from twenty-five seconds in the case of the relatively heavy spores of the *Amanitopsis vaginata* to one hundred seconds with the light spores of *Collybia dryophila*. Where the fungi grow out from trees (see Figure 79), or form shelf-like projections (see Figure 76), the spores, of course, take much longer to reach the ground. Owing to the warming of the ground by day and its cooling by night, to the drying up of moisture and other causes, it is probable that even on the stillest of days, when there is no apparent breeze at all, the air immediately above the surface of the ground is never quite still, and that even in fields and woods there is an air current of at least one or two feet per minute. Falck found that when a mass of spore-bearing tubes from a fresh specimen of *Polyporus squamosus* were pressed together, and enclosed in a specially insulated chamber for several hours, their temperature was 9·6°C. higher than that of similar tubes which had been killed by heat, and suggests that air currents produced by the higher temperature of a fungus may be of value to the plant in the dispersal of its spores. I have myself observed a raised temperature compared with that of the external air, sufficient to be detected by the hand, in the interior of a rapidly developing specimen of the Giant Puffball (*Calvatia gigantea*) (see Figure 75); but whether there is any rise of temperature on the surface of fungi of the mushroom type has yet to be demonstrated. Falck also suggests that certain toadstools have developed thickened caps and stems, on which maggots feed, so that these creatures may produce sufficient heat to form convection currents and help in the distribution of spores. It is probable, however, that maggots do more harm than good to most fungi by weakening the stalk and interfering with the exactly vertical position of the gills; and that, except perhaps where a fungus is much enclosed by dead leaves or surrounding objects, the heat produced by the plant itself or by contained maggots is of very little importance in spore dispersal.

The larger fungi, bearing spores produced on their outer surface, which are dispersed by the wind, can be divided into two main classes, the "Long-shooters," or Ascomycetes, and the "Short-shooters," or Hymenomycetes (Basidiomycetes). In both forms the spores are forcibly shot off from the cells that bear them; but whereas in the Short-shooters the spores never travel for more than a small fraction of a millimetre before all momentum is lost, and gravity alone affects them, in the Long-shooters the spores are shot out forcibly a distance of one to several centimetres. In both kinds the spores are very adhesive, and stick to anything they touch. If a toadstool, for example, which is rapidly shedding spores, as seen by the beam of light method, be turned gills upward and left several hours, and then again inverted and examined by a beam of light, no sudden rush of falling spores will be noticed, but spore discharge will begin and continue at exactly the same rate. Bearing in mind, then, the sticky nature of the spore, it

*An interesting permanent preparation can be made by taking an ordinary undeveloped lantern slide or photographic plate. All the silver is dissolved out in "hypo," and the plate washed and excess of water drained off. It is then laid, film upward, on a flat surface and the toadstool placed, gills downward, upon it.

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will be seen that in both forms it is necessary to have the spore-bearing surfaces at such a distance from other free surfaces that the spores when shot out do not strike and adhere to the latter. In the higher members of both forms an increase in the area of the spore-bearing surface has been accomplished by folding, which has resulted in gills, tubes, and so on. There is this difference, however, that whereas in the Long-shooters the folds have to be relatively far—in most cases at least a centimetre —apart, in the Short-shooters they can come within a fraction of a millimetre of one another if there be a space below down which the spores can fall. The result of this has been that the Short-shooters have been able to develop a relatively much larger area of spore-bearing surface, and perhaps largely for this reason, both in number and variety of species, Short-shooter toadstools, with gills and tubes, have become the most successful of the larger fungi.

In nearly all the Short-shooters (Hymenomycetes) the spores are borne in groups of four on outgrowths from the free extremity of elongated cells — the basidia. The spores are shed one after the other at intervals of a few seconds or minutes. A double-cell wall seems to develop between the basidium and the spore, and by increase of tension in the basidium or spore, or both, a strain is set up, and separation between these two suddenly occurs, and the spore is jerked off without rupture or injury to the basidium. The Long-shooters (Ascomycetes) have a number of much elongated cells (asci) packed closely together. In each ascus, near its free extremity, are eight spores arranged one above the other. Spore dispersal takes place by rupture of the ascus at its tip. Then the eight spores, with a certain amount of cell sap, are suddenly shot out, and in some forms at once become separated from one another.

Spore dispersal in the larger Ascomycetes may sometimes be observed without the aid of the beam of light method. I had laid the specimen of *Helvella lacunosa* shown in Figure 81 on a sheet of glass in an empty room, intending to photograph it, but was called away. When I returned several hours later I happened to touch the glass with my hand, when the upper part of the fungus, for a distance of about two inches around, became immediately surrounded by a sort of halo, which was easily seen in ordinary daylight, and remained in position for several seconds. On tapping the glass again nothing further happened, but I was able to repeat the observation and demonstrate it to another about an hour later. This " puffing " or sudden discharge of spores has been noted in many other species of the Ascomycetes. Probably the sudden shock is sufficient to determine the rupture of a number of asci which are ready to discharge their spores, and " puffing " results.

In *Helvella* the spore-bearing surface is irregularly folded, or saddle-shaped, and raised above surrounding objects by a stalk. *Helvella crispa* (see Figure 80) is the most common species. Where the folds are deeper, so that we have the appearance of a sponge with a stalk (see Figure 83), a Morel (*Morchella*) results. But even here the folds are coarse, as already explained. In *Mitrula* (see Figure 84) the spore-bearing tissue covers the upper part of a small club, and in *Bulgaria* (see Figure 87), which grows on fallen trees, the spore-bearing surface is nearly flat. *Peziza* (see Figure 86) is a cup-shaped fungus, with the spore-bearing tissue on the inside of the cup. The spores are shot outside the cup, and are then carried away by the breeze. As will be seen by Figure 88, the cup-shaped form is of advantage to the plant by protecting the sporogenous tissue from injury during the early stages of development. In the Candle-snuff fungus (*Xylaria hypoxylon*) (see Figure 90) there are two sorts of spores: dark ascospores are borne on the lower part of the stem, and white conidia form a powdery mass around the top. Besides the above many other forms of Ascomycete are, of course, met with.

Turning now to the Short-shooters (Hymenomycetes) we find, among the less highly organised members, certain genera very closely resembling the Ascomycetes in external form. Thus *Clavaria* (Figures 89 and 94) corresponds fairly well with *Mitrula*, and *Sparassis* (see Figure 91) closely resembles *Morchella*, except that it has no stalk. Corresponding to *Bulgaria*, with a more or less plane spore-bearing surface, we have *Stereum* (see Figure 92). *Stereum* forms flat plaques placed vertically on the bark of trees and shrubs, or forms shelf-like projections, the spore-bearing surface being underneath. Sometimes, particularly when growing on fallen logs, the spore-bearing surface is uppermost, a much less effective position in the absence of wind than in the corresponding genus *Bulgaria*. Since the spores are shot out such a short distance they are almost sure to fall back and adhere to the parent plant. Somewhat resembling *Peziza* is *Craterellus* (see Figure 93), shaped like a horn of plenty, but there is this difference, that here the spore-bearing tissue is outside. Nor is it likely that many of the adherent spores of a Short-shooter would be carried far beyond the plant were they developed on the inside of a hollow cone, with its apex downward.

(*To be continued.*)

FIGURE 89. *Clavaria pistillaris.* A Hymenomycete with a club-like form.

FIGURE 90. The Candle-snuff Fungus (*Xylaria hydoxylon*) which bears two sorts of spores.

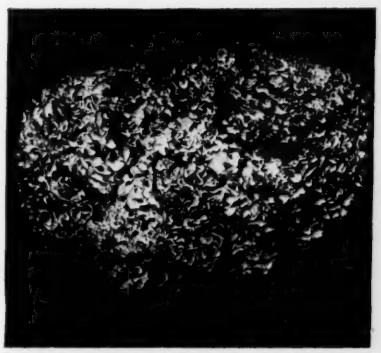

FIGURE 91. *Sparassis crispa.* A Hymenomycete resembling a large sponge.

FIGURE 92. *Stereum rugosum*, which forms flat plaques on the trunks of trees.

FIGURE 93. *Craterellus cornucopoides.* A cone-shaped Basidiomycete bearing its spores on its outer surface.

FIGURE 94. *Clavaria cineria.* A branched club-shaped species.

FIGURE 95. *Hydnum repandum.* A toadstool possessing spines instead of gills on the lower surface of its cap.

FIGURE 96. The Ringlet.

FIGURE 97. The Brimstone.

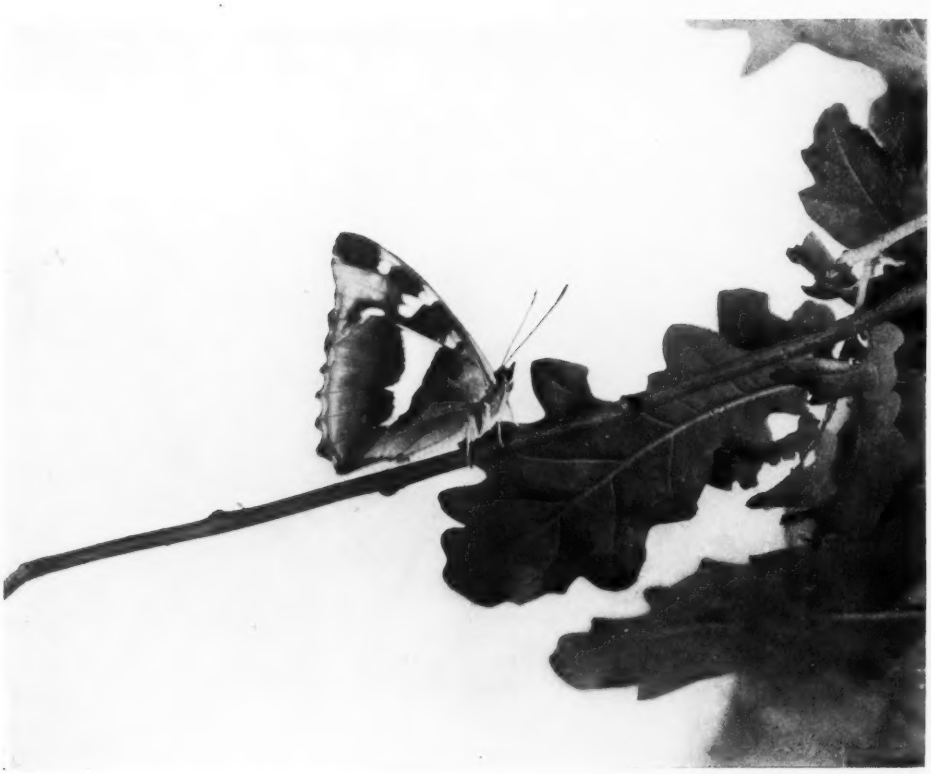

FIGURE 98. The Purple Emperor ♀.

From photographs by Douglas English.

(From "Wild Life," Vol. II. Edited by Douglas English. By the courtesy of the Wild Life Publishing Company.)

REVIEWS.

BIOLOGY.

The Twenty-Seventh Annual Report of the Liverpool Marine Biological Committee.—By W. A. HERDMAN, B.Sc., F.R.S. 70 pages. 24 illustrations. 8½-in. × 5½-in.

(Williams & Norgate. Price 1/6.)

As usual, this report contains a record of the work done at Port Erin Biological Station. Very interesting notes are given on the rearing of young lobsters, and also with regard to the minute life of the sea beach. The illustrations, particularly those of living animals, add greatly to what is quite the opposite of the usual dry and unattractive report. W. M. W.

Wild Life (Volume II).—Edited by DOUGLAS ENGLISH. 388 pages. 56 plates. 344 figures. 12-in. × 9½-in.

(The Wild Life Publishing Co. Price 25/- net.)

However useful the laboratory and the museum, however desirable a knowledge of anatomy or a training in physiology may be, there is no doubt but that it is before the field naturalist that many problems will come for solution. Moreover, the results of outdoor observations will ever continue to be a very great source of pleasure to the majority. The second volume of *Wild Life*, though it contains but four parts of the magazine, will serve to emphasise the infinite variety of the work that can be done. Its pages are only words from the daily history of the bird, butterfly, or the spider, which forms the subject of the articles written by those who know and are willing to share what they have learned with others, who maybe have not the same opportunities or turn their attention to some other creatures. It is not our intention to try and describe in detail what is a tribute to the right feeling of the times, a monument of industry and a mine of information. It is sufficient to call the attention of nature-lovers to such pictures as that of the male avocet trying to persuade the female to leave the nest, the golden eagle and her young, the web of *Epiera marmorea* covered with dew, and the purple emperor on the oak twig (see Figures 96 and 98.) W. M. W.

CHEMISTRY.

The Progress of Scientific Chemistry in our own Times.—By SIR WILLIAM A. TILDEN, F.R.S. Second edition. 8-in. × 5½-in. 366 pages.

(Longmans, Green & Co. Price 7/6 net.)

The evolution of the science of Chemistry during the past century is a fascinating story, and it loses nothing of its interest as told by Sir William Tilden. Originally the subject matter of the book was embodied in a series of lectures illustrating the progress of Chemistry in the reign of Queen Victoria, but in book form it has been expanded into something much more comprehensive and useful to the student of the science.

In this new edition the work has been brought up to date, so as to include the most recent conceptions upon such subjects as valency, stereo-chemistry, and radio-activity. The arrangement of the book into separate sections, more or less chronologically complete, is retained, and each chapter gains much in interest and value by the addition of the short biographical sketches of the different chemists who have contributed to the progress of their particular branches of chemical science. As the author rightly points out, the student of to-day may learn much from a careful study of the difficulties surmounted by the chemists of yesterday.

The evidence for and against particular theories is fairly given, and it is suggested (page 137) that in such a position of conflicting views as are held, for example, upon the structure of the atom " it is the duty and the best interest of the chemist to preserve a perfectly unbiased mind, and to pursue the safe path of experimental enquiry." This is quite compatible with the conclusion that, although atoms in the more generally accepted sense are capable of disintegrating under stress of electrical forces, they yet preserve their independence under the conditions of ordinary chemical changes.

The book is one that will interest, not only the chemist, but also the general reader. It is printed in type that is pleasant to read, and has a good index and full references to the authorities cited. C. A. M.

DRESS.

Dame Fashion, 1786–1912.—By JULIUS M. PRICE. 180 pages. 155 coloured plates. 10½-in. × 7½-in.)

(Sampson Low, Marston & Co. Price 63/- net.)

In his preface the author criticises the works on costume published in England, because, though their number is legion, they " all, without exception, treat the subject from its picturesque aspect only." The present reviewer some years ago did attempt to consider clothes from an evolutionary point of view, and when taking up " Dame Fashion " he did so with the hope that he might find something with regard to the origin of particular features in dress or the causes of fashion. It is true that the author sees in clothes a reflection of history, and he has certainly given in his account of the period which lies between the years 1786 and 1912 a very remarkable and fascinating story. With regard to the illustrations it may be said all the coloured figures are taken from fashion-plates. This may insure accuracy as regards details, but, judging from the costumes as we see them in the streets or the ballroom, we should say that fashion-plates do not give an entirely truthful idea of the looks of the people at any particular time. From a developmental point of view men's dress is more interesting than that of women, but only the latter has been considered to be worth illustrating in the present case. W. M. W.

ECOLOGY.

The Journal of Ecology, Volume I, No. 4.—Edited by FRANK CAVERS. 250–314 pages. 27–41 figures. 14–28 plates. 10-in. × 7¼-in.

(The Cambridge University Press. Price 5/- net.)

This part contains an important article by Professor F. W. Oliver and Mr. E. J. Salisbury on " Vegetation on Mobile Ground as illustrated by *Suaeda fruticosa* on Shingle." The article forms the eighth publication based on observations made at Blakeney Point, which the National Trust has taken over through the efforts of the Society for the Promotion of Nature Reserves. It is shown in the article that if the plant considered, is established it will, as the beach slowly travels over it, respond by continually growing to the surface. By its great capacity for rejuvenescence and power of arresting the travel of shingle, thus raising the height of a beach, *Suaeda* would appear to be pre-eminently adapted for planting on shingle spits and similar formations where the object is to stop the landward travel. Another article forming Blakeney Point Publication No. 9, by William Rowan, deals with the food plants of rabbits. One of the great features of this journal is the reviews and notes on all matters concerned with ecology all over the world. W. M. W.

EDUCATION.

The Montessori Principles and Practice.—By E. P. CULVERWELL, M.A., Fellow and Senior Tutor, Trinity College, Dublin, Professor of Education, University of Dublin. 309 pages. 19 illustrations. 7⅜-in. × 4¾-in.

(G. Bell & Sons. Price 3/6 net.)

A work on this subject—the last word in the world of education — is very welcome from so able a writer as Professor Culverwell, and his book is a valuable addition to Montessori literature.

It is written in a most interesting manner, expounding the scientific principles which underlie Madame Montessori's methods. The chapters on Spontaneity and Liberty are particularly good, and the whole subject is

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treated with insight and understanding. Unfortunately, it is decidedly easier to get hold of Montessori apparatus than Montessori principles, but a careful study of Professor Culverwell's book would insure that the former would not be used without some considerable knowledge of the latter.

A. A.

FUNGI.

Toadstools and Mushrooms of the Countryside.—By EDWARD STEP, F.L.S. 143 pages. 135 illustrations. 6¼-in. × 4¼-in.

(Hutchinson & Co. Price 5/- net.)

Mr. Step has done a great deal to popularise botany in this country, and his delightful photographs are well known. This little book is one of a series called "Popular Pocket Nature Books," provided with rounded corners, so that they may be taken into the field. The main object, of course, is to enable nature-lovers to identify the toadstools that they come across. The photographic reproductions and the clear descriptions go a very long way to encompassing this, and we feel sure that Mr. Step's "Toadstools and Mushrooms of the Countryside" will be welcomed by all those who want a good deal of information in a compact form.

W. M. W.

NATURAL HISTORY.

Cassell's Natural History.—By F. MARTIN DUNCAN, F.R.P.S. 432 pages. 16 coloured plates. Over 200 illustrations. 9½-in. × 6-in.

(Cassell & Co. Price 9/- net.)

An excellent feature of this volume, and one in which it differs widely from a number of its rivals, is the relatively large amount of space accorded to invertebrates, this portion of the work being nearly equal to that assigned to vertebrates. A second feature, which ought to appeal strongly to the public, is the beauty and excellence of the illustrations, especially of the sixteen coloured plates. The one fault in connection with the latter is the absence, in certain instances, as in the group of shells facing page 101 and of tropical butterflies opposite page 146, of any clue to the species depicted. In the case of the shells it might, indeed, puzzle the tyro to decide which are bivalves and which univalves, as the latter shells might easily be mistaken for one valve of a bivalve. Seeing that in other plates the individual figures are properly numbered and named, it is difficult to understand the reason for the omission in the plates mentioned. A lack of reference in the text to the photographic plates is also noticeable, and in consequence of this, for example, the reader has no clue by which to identify the young Somali hyaenas represented in the plate facing page 377 with the spotted hyaena referred to on page 380.

As the author states, the book is written, in the main in simple and non-technical language, although the statement on page 105, that "*Crepidula* is a protandric hermaphrodite," is calculated to terrify a beginner, despite the fact that it is followed by a partial explanation. Misprints seem few and far between, although on page 138 we note *Paripatus* for *Peripatus*, and on page 377 *Nyctereutes* for *Nyctereutes*.

So far as the sections devoted to the invertebrates are concerned, the work appears to be in the main excellent, and the information given trustworthy and up to date. The author, in fact, knows his subject. We wish the same could be said for the vertebrate portion, more especially the mammalian section. In parts of this—notably the chapter on Ungulates—the text can only be described as disgraceful. What, for instance, is to be thought of an author who tells his readers (page 350) that there are three species of zebra—the true zebra, Burchell's zebra, and the quagga—and who figures (plate facing page 348) the second of these as the first? Has he never heard of the Somali Grévy's zebra? Again, it is a bit behind the time to quote the late Sir W. H. Flower to the effect that the only approximation to true wild horses at the present day are the tarpan of the Russian steppes, the author being apparently unaware that these are extinct, and seeming to be quite unacquainted with the existence of real wild horses in the Gobi. These are only a few instances among many that might be cited, and the truth is that no man can write an entire natural history. If the work before us reach a second edition, the best thing the author can do is to invoke the assistance of a coadjutor who knows at least something about mammals.

R. L.

PHOTOGRAPHY.

The American Annual of Photography, 1914. 328 pages. Numerous illustrations. 8¾-in. × 6-in.

(George Routledge & Sons. Price 75 cents, or 3/6.)

This annual is of the class in which the articles and illustrations are contributed by photographic workers who have responded to an invitation to send a paper telling of experience, or experiments, in any branch of photographic work, or to send prints for illustration. There are over fifty contributed articles. The annual is not a "text book," but the papers contain a great deal of information, and also personal experiences, written in an interesting and captivating manner, which cannot be otherwise than helpful to one who, whether a novice or an advanced student in the art, would like to know something of the work and experiences of others. We are pleased to find an old acquaintance amongst the contributors: Mr. E. J. Wall, F.R.P.S., who gives a formula for a developing solution which the writer believes to be the same as that which he advocated before he took up his residence on the other side of the Atlantic.

The book is profusely illustrated with impressions from half-tone blocks, which comprise a variety of subjects and styles. Amongst the illustrators are the names of some whose work is well-known in this country.

A "Formulary" is appended with a head-note stating that the formulae are selected, not from "makers' formulae," but from the working methods of practical photographers. This is supplemented by a collection of useful tables, and a list (which is admitted to be incomplete) of American photographic societies. The book is not overcrowded with advertisements, and is worthy of a place in any photographer's library.

J. W.

PHYSICS.

Practical Exercises in Heat.—By E. S. A. ROBSON. 213 pages. 94 figures. 7½-in. × 5-in.

(Macmillan & Co. Price 3/6.)

This useful book, after several reprints, appears in a second edition. Many additions have been made both to the experiments and to the examination questions, while the very convenient tables at the end have been carefully revised and extended. A more complete practical manual would be difficult to find.

W. D. E.

Mechanics and Heat.—By J. DUNCAN. 381 pages. 314 diagrams. 7½-in. × 5-in.

(Macmillan & Co. Price 3/6.)

This book appears to contain the substance of the author's "Applied Mechanics for Beginners," with the addition of an elementary treatise on Heat, written from the point of view of the practical engineer, and eminently suitable for the student who wishes to become acquainted with the more practical applications of the subject. The chapters at the end on locomotive engines, small steam engines, and motor engines are attractive and likely to be useful.

W. D. E.

Sound (Cambridge Physical Series).—By J. W. CAPSTICK. 296 pages. 120 figures. 7½-in. × 5-in.

(The Cambridge University Press. Price 4/6.)

The study of acoustics has fallen out of the ordinary school course of physics ever since the Army examinations

ceased to include Sound as a subject. Moreover, at Cambridge it has been customary to regard the ability to perform experiments in sound as "the gift of God." Certainly we have had to wait a long time for a textbook more elementary than Lord Rayleigh's great work. The latest addition to the well-known series, which includes Glazebrook's "Heat and Light," will be welcome both to students of physics and of music, and is a worthy member of the family. It is surprising to find no reference to Professor Wood's photographs of sound-waves.

W. D. E.

REFERENCE BOOKS.

The New Encyclopaedia.—Edited by H. C. O'NEILL. 1626 pages. Illustrated. 10¼-in. × 7-in.

(T. C. & E. C. Jack. Price 7/6 net.)

In the twentieth century it seems a brave thing to attempt to compile an encyclopaedia which shall not exceed in dimensions a single handy volume, but Mr. O'Neill has managed, with the help of his staff, to give brief explanations of hosts of words, things, people, and places which will serve to refresh the memory of many, and to give just that amount of explanation which may be necessary at the moment in connection with some matter of everyday interest. We have looked up a number of subjects, and have found some which we did not expect to see, while we have been surprised at the amount of space that it has been possible to give to scientific and natural history matters. "The New Encyclopaedia" should be on everyone's writing-table.

W. M. W.

WILD LIFE IN CRETE.

Camping in Crete, with Notes upon the Animal and Plant Life of the Island.—By AUBYN TREVOR-BATTYE, F.R.G.S. 308 pages. 32 plates. 9-in. × 5½-in.

(Witherby & Co. Price 10/6 net.)

It is with great pleasure we welcome another work by the author of "Ice-bound on Kolguev" (1895), for few writers wield a more facile pen in the description of scenery and wild life than Mr. Trevor-Battye, who, moreover, has the further advantage of being a trained and observant field naturalist, and is also, as demonstrated by the beautiful plates in the work before us, an adept in the use of the camera. Despite the researches of Sir Arthur Evans amid the ruins of the pre-Roman city of Knossos, of Professor Keller's investigations with regard to the connection between the extinct wild bull and the legend of Theseus and the Minotaur, and the explorations of Miss Dorothea Bate (who contributes an appendix to the volume) in the caverns of the island, Crete still remains an unknown land to the great majority of Englishmen. The reason for this, the author suggests, is that, although the island lies so close to the track of eastward-bound liners that its snowy peaks may be seen from their decks, yet it is awkward to approach, so that it is visited by few English people save archaeologists. Nevertheless he has little doubt that it will some day be "discovered," and become a more or less popular resort, as, indeed, from its climate and scenery, it has full claim to be.

Although the author says he has no concern with either antiquaries or politicals, yet he cannot help alluding to the present status and future political prospects of the island, whose inhabitants, after having thrown away a chance of stable settlement, now dream they will be happy in the arms of Greece!

To follow Mr. Battye in his wanderings from village to city, and from valley to mountain, is incompatible with the space at our disposal, and it must suffice to state that his narrative and illustrations collectively form one of the most delightful books of modern travel it has been our good fortune to peruse. To the naturalist the author's notes on the birds and the flora of the island, and those on the mammals by Miss Bate, will not fail to appeal; the special features of the mammal fauna being the occurrence of peculiar species of wild cat, weasel, and spiny mouse, the last of these belonging to a genus elsewhere known only from Africa, Cyprus, and Asia Minor.

R. L.

ZOOLOGY.

The Snakes of Europe.—By G. A. BOULENGER. 269 pages. 14 plates. 42 figures. 7½-in. × 5-in.

(Methuen & Co. Price 6/-.)

Mr. Boulenger has not only given an account of the snakes of Europe, but he has by way of introduction prepared a dozen or more chapters dealing with the whole subject of snakes, their classification, structure, habits, and distribution. His remarks on the relation of the reptiles to man include an account of snake-charmers. Mr. Boulenger says it is a mistake to think that a deadly snake is rendered harmless through the poison-fangs having been extracted, although this subterfuge is frequently resorted to by the less-accomplished jugglers. The immunity of the snake-charmer, we are told, is explained by the fact that the man has submitted himself to a series of successive graduated inoculations of the venom, a process similar to vaccination, which renders his blood proof against the venom of the particular species of snake—and that one only—which is used for his performances. More than twenty thousand human lives are lost every year in India through snake-bites. The only effective antidote is a serum produced from an animal which has been treated for some time with the venom of a poisonous snake, and which is antitoxic towards the poison of that particular species. The results would be greater if the venoms could be obtained in sufficient quantity to immunise the animals required, for a different serum is wanted in the case of each poisonous snake. In England instances of death from the bite of the viper are very few and far between, but in France and other Continental countries there are several fatal cases every year.

With regard to the systematic part of the book it is worthy of note that there is no work in the English language dealing with the reptiles of Europe, and therefore Mr. Boulenger's account of the snakes is of particular importance and value.

W. M. W.

Our Common Sea Birds.—By PERCY R. LOWE. 310 pages. Numerous illustrations. 12-in. × 8½-in.

(Country Life. Price 15/- net.)

This is the first of two volumes which are to deal with our common sea birds, and the present book touches on cormorants, terns, gulls, skuas, puffins, and auks. The pictures are by many well-known bird photographers, and those at the beginning of the book, which illustrate the flight of birds, are particularly striking. We also commend to our readers the figures of guillemots, razorbills, and puffins.

W. M. W.

CORRESPONDENCE.

EROSION.

To the Editors of "KNOWLEDGE."

SIRS,—I have been struck by some remarks in the Notes on Geology ("KNOWLEDGE," Volume XXXVII, page 31) with reference to Erosion and the Age of the Earth. It is there argued that the rate at which erosion works must be estimated in the basins of those rivers where man is scarce or absent rather than in those where man is settled in large numbers, because man himself is a powerful agent in increasing the rate of erosion through cultivation. The Ganges and Mississippi are mentioned as useless for purposes of calculation owing to the dense population dwelling on their banks, and the Rio Grande is suggested as the normal type from which an accurate estimate of the rate of erosion can be made.

XUM

I have no argument to advance as to the age of the Earth, nor do I wish to deny the fact that cultivation may to some extent tend to raise the rate of erosion. But is not the converse proposition, namely, that man has tended to settle where the rate of erosion is greatest, much more in accordance with facts? A high rate of erosion is usually coincident with a heavy rainfall, and these two facts together tend to make the wide fertile plains which naturally are the chief habitat of man on this Earth. Is not the vast population supported on the plains of the Ganges the result rather than the cause of the speed of erosion in those parts bringing fertility in its wake? Would the immigration of any number of men to the Rio Grande Valley appreciably affect the rate of erosion? Is it not rather true that the slowness of erosion in those parts consequent on the low rainfall precludes the settlement of man in any great numbers?

The writer of that paper's arguments for the Age of the Earth seem to me of as little value as those of other men of science of whom he makes ridicule.

The Notes above referred to, together with the Notes on Meteorology immediately following, which record some rainfalls in America and England, reinforce my opinion that English scientific men are apt to base their conclusions with regard to erosion on what they see in Great Britain rather than on what they see in many other parts of the world. The normal rate of erosion will appear very different if it is estimated from the Perthshire mountains, where the scratches of the Ice Age are still in evidence on the mountain-tops, or from such a place as Japan, where I have seen a valley which I estimated at forty feet deep filled up with detritus in a space of twenty-four hours, so that the stream at the bottom overflowed and took a new course on the other side of a large hill. This was the result of twenty-five inches of rain falling in twenty-four hours, and I can well remember standing on a hill a few days later from which full fifty scars were visible on the surrounding mountains, each one the result of a landslip. I have not the records by me just now, but, if I remember aright, the Government estimate was that eighteen thousand landslips took place as the result of that one storm; any estimate of the amount of soil carried down to a lower level (from a height chiefly above the ordinary human habitation) would be impossible; but I suppose erosion accounted for more in that one day in Japan than it has in Great Britain in the last hundred years.

It may interest your readers to know the rainfall as measured then by a Beck's automatic rain-gauge. During the first half of the month (August, 1910) the daily fall in inches was as follows: ·11, ·30, ·50, 1·45, ·35, ·80, ·93, 2·46, 9·00, 20·58, ·02, 1·55, 10·92, ·93, ·98, 1·54, or well over fifty inches in the fortnight. These records were made at nine a.m. each day. The heaviest rain ceased at an early hour in the morning, and, as stated above, during the last twenty-four hours of rain twenty-five inches fell.

During the same days this year in Japan my rain-gauge only registered ·67 inch altogether!

With apologies for trespassing so much on your space.

J. GURNEY BARCLAY.

MATSUYE,
JAPAN.

GRAVITATION.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Cairns's essay on gravitation in the February number of "KNOWLEDGE" is very interesting, but he, like Le Sage, in trying to account for gravitation whose force is a pull, has fallen back on similar "multitudinous, ubiquitous," and mythical flying particles, which are now named electrons, and the force of which could only be a push. If Newton had but accepted the vibration theory instead of the emission, he would assuredly have told us that vibration is the origin of gravitation.

Gravitation is not intermittent, but is a constant force; and as no force can act except through the medium of material, and as there is no material between us and the Sun but the aether, and as the aether has no movement but vibration, solar gravitation must be a constantly recurring vibration of the aether—due either to the vibrations that are known to be sent to us from the Sun, or to some other set that is unknown—and it is extremely unlikely that terrestrial gravitation should differ from this in any way.

We cannot see the vibrations of aether or their action on material, so we must judge of these by the actions of such vibrations as are sensible to us, and the following are examples of such vibrations and of their effects.

Two men holding the ends of a rope will be drawn towards each other if they send a vibration along the rope.

On occasions when disastrous explosions have occurred, it has been noticed that the windows of houses have—as it has been described—been blown out. The first severest part of the sound vibration drew them towards the point of origin of the sound.

Ripples in water draw small floating objects together, and Professor Bjerkness found by experiment that elastic bodies immersed in water and made to pulsate are drawn towards one another.

The vibrations of electricity and magnetism are due to particular activity, and produce actions of attraction and repulsion in no way resembling gravitation, so they cannot be referred to in regard to our subject. In all the instances given, the pull is due to a force of vibration acting across the line of pull. The aether vibration is said to be a cross vibration, and should therefore also produce a pull; but to understand how it acts is exceedingly difficult, if one endeavours to realise what its system of wave motion is from a study of the published descriptions given, which indeed, speaking personally, are unintelligible; and it is hoped that the following more simple simile may be more illuminating.

Supposing that a tube of very thin, flexible rubber were suspended by one end, and that a bullet were dropped down it, the course of the bullet would be shown outside as a swelling of the tube in the shape of an egg with tapered ends; and if other bullets were dropped in at correct intervals the swellings would follow one another in such a way that an outline drawing of any side of the tube would show the ordinary conventional wavy line that represents wave motion.

There are evidently two forces acting on the tube, a progressive force in the line of direction of the wave and a transverse force across that line; and the transverse force must draw whatever the wave acts on towards the point of origin of the wave.

The aether wave differs then in no way from the ordinary wave, except that, being confined to no surface but free all round, its crest rises as a ring at right angles to its line of direction.

With such an aether wave all the puzzles of polarisation of light are easily explained.

The aether has no weight of material that can make the propulsive force of its waves felt, but its transverse wave force can and does, as we know, act on the molecules of matter, and the first part of its action is to draw the molecule towards the point of origin of the aether wave—and this is gravitation.

It appears then that every aether wave should produce gravitation, and acting on every substance should cause those mutual attractions that pass under such names as cohesion, contraction, affinity, crystallisation, and so on, and in every case the amount of mutual force is $\frac{G \times g}{d^2}$.

The above solution has been put as simply as possible, but it must not on that account be supposed to be a mere light guess, for it was arrived at only after much study of the subjects connected with wave motion, and especially that of the polarisation of light.

W. F. BADGLEY.

DEVIZES.

THE FACE OF THE SKY FOR APRIL.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 13.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
Apr. 3	0 47·4	N. 5·1	6 40·9	N. 27·9	23 8·8	S. 7·0	1 35·4	N. 9·1	7 16·2	N. 24·8	21 12·8	S. 16·7	4 49·1	N. 21·1	7 49·3	N. 20·7
,, 8	1 5·7	7·0	11 17·5	N. 4·2	23 27·0	5·8	1 58·7	11·5	7 25·0	24·4	21 16·2	16·4	4 51·0	21·2	7 49·3	20·7
,, 13	1 24·0	8·8	16 3·9	S. 26·0	23 48·8	3·9	2 22·2	13·7	7 34·2	24·0	21 19·5	16·2	4 53·0	21·3	7 49·3	20·7
,, 18	1 42·5	10·6	20 58·1	S. 20·1	0 13·5	S. 1·4	2 46·2	15·8	7 43·8	23·5	21 22·6	16·0	4 55·1	21·3	7 49·4	20·7
,, 23	2 1·1	12·3	0 36·9	N. 6·5	0 40·8	N. 1·5	3 10·5	17·7	7 53·6	23·1	21 25·4	15·8	4 57·3	21·4	7 49·6	20·6
,, 28	2 20·0	N. 14·0	4 34·3	N. 27·1	1 10·7	N. 4·9	3 35·4	N. 19·5	8 3·6	N. 22·4	21 28·0	S. 15·6	4 59·6	N. 21·5	7 49·8	N. 20·6

TABLE 14.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Apr. 3	−26·3	−6·4	96·7	+ 3·4	−16·2	+ 7·0	63·4	7 39 *m*	−19·3	−0·2	310·2	210·7	3 30 *m*	6 11 *m*
,, 8	26·4	6·1	30·7	+21·5	15·0	7·9	15·9	10 54 *m*	19·5	0·2	19·2	241·6	9 18 *e*	3 15 *e*
,, 13	26·3	5·7	324·7	+10·9	13·8	8·8	328·3	2 10 *e*	19·7	0·1	88·3	272·4	9 34 *m*	4 28 *m*
,, 18	26·0	5·3	258·6	−14·9	12·5	9·8	280·7	5 26 *e*	20·0	0·1	157·4	303·4	5 32 *e*	11 29 *e*
,, 23	25·5	4·8	192·6	−21·8	11·2	10·7	232·9	8 42 *e*	20·2	0·1	226·5	334·4	5 48 *m*	0 41 *e*
,, 28	−24·8	−4·3	126·6	− 8·4	− 9·8	+11·7	185·0	11 59 *e*	−20·3	−0·0	295·8	5·5	11 35 *e*	1 54 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II. to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward march but with slackening speed. Its semi-diameter diminishes from 16′ 2″ to 15′ 54″. Sunrise changes from $5^h\ 40^m$ to $4^h\ 38^m$; sunset from $6^h\ 30^m$ to $7^h\ 18^m$.

MERCURY is a morning star. Semi-diameter 3½″. Illumination increases from ⅜ to ¾. At West Elongation (27° 46′) $7^d\ 7^h m$.

VENUS is an evening star, but still too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. Superior conjunction was on February 11th.

THE MOON.—First Quarter $3^d\ 7^h\ 41^m\ e$; Full $10^d\ 1^h\ 28^m\ e$. Last Quarter $17^d\ 7^h\ 52^m\ m$. New $25^d\ 11^h\ 22^m\ m$. Perigee $10^d\ 10^h\ m$. Apogee $23^d\ 5^h\ e$, semi-diameter 16′ 46″, 14′ 43″ respectively. Maximum Librations, 1^d 7° S, 4^d 8° E, 14^d 7° N, 16^d 8° W, 28^d 7° S, May 2^d 7° E. The letters indicate the region of the Moon's limb brought into view by libration. E. W., are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 16.)

MARS is slowly advancing. It is about 4½° South of Pollux on 16th, 2½° North of Neptune on 21st. Near Moon on 4th, $3^h\ m$. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during April diminishes from 4″ to 3″. The unilluminated lune is on the East: its width diminishes from ⅘″ to ⅙″.

JUPITER is still rather badly placed, having been in conjunction with the Sun on January 20th. It is a morning star. Polar semi-diameter, 17″.

Configuration of satellites at $4^h\ m$ for an inverting telescope

TABLE 15.

Day.	West.		East.		Day.	West.		East.	
Apr. 1	4231	○			Apr. 16	2	○	41	3●
,, 2	4	○	13	2●	,, 17	41	○	23	
,, 3	4	○	23	1●	,, 18	4	⊙	13	
,, 4	421	○	3		,, 29	42	○	13	
,, 5	42	○	31		,, 20	431	○	2	
,, 6	431	○	2		,, 21	43	○	12	
,, 7	34	○	21		,, 22	4321	○		
,, 8	3214	○			,, 23	42	○	1	3●
,, 9		○	314	2●	,, 24	41	○	23	
,, 10	1	○	234		,, 25		○	213	4●
,, 11	2	⊙	34		,, 26	2	○	34	1●
,, 12	2	○	134		,, 27	31	○	24	
,, 13	31	○	24		,, 28	3	○	124	
,, 14	3	○	124		,, 39	321	○	4	
,, 15	321	○	4		,, 30	23	○	14	

The following satellite phenomena are visible at Greenwich, all in the morning hours, $2^d\ 4^h\ 53^m\ 56^s$ II. Oc. R.; $4^h\ 58^m\ 55^s$ I. Sh. I.; $3^d\ 5^h\ 33^m\ 13^s$ I. Oc. R.; $8^d\ 4^h\ 21^m\ 39^s$ IV. Oc. D.; $10^d\ 4^h\ 0^m\ 52^s$ I. Ec. D.; $11^d\ 3^h\ 36^m\ 27^s$ I. Sh. E.; $4^h\ 46^m\ 43^s$

XUM

I. Tr. E.; $16^d\ 5^h\ 0^m\ 23^s$ II. Ec. D.; $18^d\ 3^h\ 14^m\ 19^s$ I. Sh. I.; $4^h\ 27^m\ 48^s$ I. Tr. I.; $4^h\ 49^m\ 0^s$ II. Tr. E.; $19^d\ 3^h\ 58^m\ 31^s$ I Oc. R.; $25^d\ 4^h\ 23^m\ 38^s$ IV. Oc. R.; $4^h\ 36^m\ 30^s$ II. Tr. I.; $27^d\ 3^h\ 8^m\ 19^s$ I. Tr. E. Attention may be called to the fact that Professor R. A. Sampson's new tables of Jupiter's satellites are used for the first time in the Nautical Almanac; we may expect a considerable increase of accuracy in the predictions.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is approaching the Sun, but is still observable as an evening star. Polar semi-diameter 8″. P. is −4°·5; B−26°·8. Ring major axis 40″, minor 18″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on June 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $3^d\ 3^h{\cdot}1m$, $10^d\ 4^h{\cdot}4e$; Dione (every third given), $2^d\ 10^h{\cdot}7e$, $11^d\ 4^h{\cdot}0m$; Rhea (every second given), $2^d\ 11^h{\cdot}7m$, $11^d\ 0^h{\cdot}8e$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $2^d\ 9^h{\cdot}4e$ S., $7^d\ 0^h{\cdot}6m$ E., $11^d\ 0^h{\cdot}5m$ I., $14^d\ 9^h{\cdot}5e$ W.; Iapetus, $15^d\ 2^h{\cdot}9e$ E.

URANUS is a morning star, but badly placed, having been in conjunction with the Sun on January 28th. It was 9′ south of Jupiter on March 4th.

TABLE 16. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Mean Time.	Angle from N. to E.
1914.			h. m.		h. m.	°
April 3 ...	BD+26°1481	7·0	11 3 *e*	82°	—	—
,, 6 ...	Wash. 630	6·7	2 23 *m*	112	—	—
,, 7 ...	Regulus	1·3	3 27 *m*	117	4 16 *m*	296
,, 8 ...	56 Leonis	6·1	0 36 *m*	118	1 36 *m*	310
,, 8 ...	Wash. 759	6·8	7 3 *e*	63	—	
,, 10 ..	BD−12°3830	6·8			8 13*e*	4
,, 11 ...	85 Virginis	6·1	3 36 *m*	90	4 33 *m*	320
,, 11 ...	BAC 4814	6·5	10 10 *e*	105	11 13 *e*	316
,, 14 ...	BAC 5603	6·0	0 22 *m*	124	1 29 *m*	266
,, 29 ...	BAC 1848	5·6	7 15 *e*	72	8 12 *e*	205
,, 29 ...	136 Tauri	4·6	8 31 *e*	137	9 16 *e*	239
,, 29 ...	BAC 1918	6·1	11 29 *e*	89	0 17*·*m	283

The asterisk indicates the day following that given in the date column.

From New Moon to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultation of Regulus on 7th; the star is low in the west.

TABLE 17. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
RX Virginis	12 0	− 5·3	7·4 to 9·0	irregular	
RW Virginis	12 3	− 6·3	6·8 to 7·7	irregular	
T Virginis	12 10	− 5·5	8·2 to 13·4	339·5	April 20.
RV Urs. Maj.	12 16	+61·8	7·2 to 8·3	315	About April.
SS Virginis	12 21	+ 1·3	7·2 to 9 0	unknown	
Y Virginis	12 30	− 3·9	8·5 to 13·4	218·8	May 5.
T Urs. Maj.	12 33	+60·0	5·5 to 12·7	257·2	May 16.
R Virginis	12 34	+ 7·5	6·2 to 11·1	145·5	February 21.
RV Draconis	12 34	+66·1	8·4 to 13·6	205	February 18.
V Urs. Maj.	12 36	+56·3	7·7 to 9·3	irregular	
S Urs. Maj.	12 40	+61·6	7·0 to 12·5	226·5	April 24
Y Can. Ven.	12 41	+45·9	4·8 to 6·0	unknown	
RV Draconis	12 53	+66·5	6·1 to 7·1	irregular	
SW Virginis	13 10	− 2·3	7·4 to 8·8	irregular	
V Can. Ven.	13 16	+46·0	7·5 to 8·0	unknown	
V Virginis	13 23	− 2·7	8·0 to 13·8	250·5	April 23.
R Hydrae	13 25	−22·8	3·5 to 10·1	425·15	June 4.
T Urs. Min.	13 33	+73·9	8·8 to 13·9	321	February 10.
V Urs. Min.	13 37	+74·7	7·5 to 8·7	71	March 18, May 28.
R Can. Ven.	13 45	+40·0	7·4 to 12·2	328	April 30.

Principal Minima of β Lyrae April $12^d\ 6^h e$, $25^d\ 4^h e$. Period $12^d\ 21^h{\cdot}8$.

Algol minima Apr. $6^d\ 1^h\ 24^m m$, $8^d\ 10^h\ 12^m e$, $11^d\ 7^h\ 6^m e$, $14^d\ 3^h\ 54^m e$, $26^d\ 3^h\ 6^m m$, $28^d\ 11^h\ 54^m e$. Period $2^d\ 20^h\ 48^m\ 55{\cdot}6^s$.

Mira Ceti reaches maximum on March 17th, Mag. 2·0; it is, however, too near the Sun for convenient observation.

NEPTUNE was in opposition on January 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night. It is $2\frac{1}{2}°$ south of Mars on 21st.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 17.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar.-May ...	263°	+ 62°	Rather swift.
Apl. 12-24 ...	210	− 10	Slow, fireballs.
,, 16-25 ...	301	+ 23	Swift, streaks.
,, 18-23 ...	189	− 31	Slow, long.
,, 20-21 ...	261	+ 36	Swift, bluish white.
,, 20-22 ...	271	+ 33	Conspicuous shower, swift.
,, 20-25 ...	218	− 31	Slow, long paths.
,, 30 ...	291	+ 59	Rather slow.
Apl.-May ...	193	+ 58	Slow, yellow.
Apl.-May ...	296	+ 0	Swift, streaks.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

OBITUARY.—I have been discussing Sir David Gill's "History of the Cape Observatory" in several recent numbers of "KNOWLEDGE." I have now to turn from it to record his lamented death, which removes one of the most conspicuous figures from the ranks of British astronomers. He was present at the meeting of the Royal Astronomical Society in December, and appeared in his usual health and spirits; but almost immediately after it he was attacked by pneumonia, and after a long struggle he succumbed. He may be said to have died in harness, for though he retired from the Cape Observatory in 1906, after twenty-eight years of strenuous service, his boundless energy led him to take an active part in the work of many scientific bodies, which will feel his loss acutely. M. Baillaud is coming to the March meeting of the Astronomical Society to express the grief felt among foreign astronomers at his death, and their sense of his great services to Astronomy, more especially in the matter of the Astrographic Chart. It will be remembered that it was the success in photographing faint stars on the Cape photographs of the Great Comet of 1882 that led to the Paris Conference of 1887, and the subsequent partitioning of the whole sky among twenty observatories. A project having some connection with this, which Gill carried through in conjunction with Kapteyn, was the Cape Photographic Durchmusterung, by which the southern hemisphere, so long neglected, was surveyed in a more accurate manner than the northern. Gill's tenure of office was indeed a memorable epoch in southern astronomy, and will be remembered as long as the science exists.

Another well-known astronomer is dead, Professor S. C. Chandler, at the ripe age of eighty-six; he is best known for his discovery of the variation of latitude. Previous inquirers into this subject had been baffled by the false assumption that the period of the variation must be three hundred and five days. Chandler boldly put this aside, and finally found that two waves could be traced—one with a period of fourteen months, the other of a year. After these had been announced Professor Newcomb showed that the three hundred and five day period involved the assumption that the Earth was perfectly rigid; a rigidity about equal to steel would explain the fourteen-month term; this has since been verified in other ways. Dr. Chandler received the Gold Medal of the R.A.S. for this discovery. He is also well known for his work on variable stars, of which he published several catalogues. He is also known for his invention of the Almucantar, an instrument that floats in a circular trough of mercury, enabling the transits of stars over a horizontal circle to be observed. One of these instruments is mounted at Durham Observatory, and its results form a useful check on those made with meridian instruments.

The Rev. Edmund Ledger is also dead: he was the Gresham lecturer on Astronomy for many years, and also published an attractive text-book on the Solar System. I have no doubt that his books and lectures are familiar to many of our readers.

THE TOTAL SOLAR ECLIPSE OF AUGUST 21ST NEXT.—Mr. Chambers, at the January meeting of the B.A.A., emphasised the necessity that those intending to view this eclipse should make their arrangements within the next month, as the accommodation along the route is limited. Those going to Norway will probably have to sleep on board ship, as there are no considerable towns within the shadow-track. I understand that the Royal Mail Steamship Company announce a fortnight's trip, including some hours ashore on the island of Alsten on the day of the eclipse, for a minimum charge of £15. It is also possible to go to Hernosand, on the Baltic coast of Sweden: this can be reached by local steamer from Stockholm, and contains suitable hotels. The eclipse may also be seen from the Aland Islands, or Dago or Oesel, but the accommodation for tourists is probably primitive. In Russia the most accessible points are Riga, Minsk, Kiev, and the Crimea. Riga can easily be reached from England by the Wilson Line, the return fare, including board, being about £15. I am informed that the accommodation at Riga is likely to be strained to the utmost by the invasion of sightseers, so it is imperative to engage rooms in good time. Those intending to view the eclipse would do well to communicate with Mr. G. F. Chambers, Lethen Grange, Sydenham, who is secretary of the committee appointed by the B.A.A. to organise the expeditions. The duration of totality is about two minutes; the height of Sun 39°. The eclipse is about one p.m. in Norway and two p.m. in Russia. Three official parties will go from England to view the eclipse in Russia, occupying Kiev, Minsk, and Feodosia (Crimea) respectively. All will undertake photography of the corona, both small-scale pictures for the extensions, and large-scale for details of arches, and so on. The Minsk party will also study the distribution of the gas "Coronium," using a screen of "Mercury Green" glass. They will also pay special attention to the ultra-violet region of the coronal spectrum, using a quartz spectrograph. On the other hand, Fathers Cortie and O'Connor, at Kiev, will pay special attention to the yellow and red part of the spectrum; Messrs. Curtis, Fowler, and Hills, at this station, will take large-scale high dispersion photographs of the spectrum of the Chromosphere during the partial phases, using an iron-arc comparison spectrum. The possibility of this work was shown at the eclipse of April, 1912. At the last Russian totality, in 1887, the weather conditions were discouraging, but the Sun's altitude will be much greater next summer, and the parties will also be more divided, so that complete failure is unlikely.

XUM

DELAVAN'S COMET.—The orbit of this comet that was given last month proved to be much in error. The real orbit is of a much more interesting character, and indicates that when discovered the comet was at more than four times the Earth's distance from the Sun; in fact, quite near the orbit of Jupiter. It will not make its nearest approach to the Sun till eleven p.m. on October 26th, that distance being 1·1053 in astronomical units, or one hundred and three million miles; the ascending node is in longitude 59° 10′, the arc from node to perihelion is 97° 27′, and the inclination to the ecliptic 68° 6′. The comet will be at its greatest distance north of the ecliptic about the time of perihelion, which will make the conditions of observation much better for northern observers. There is little doubt that it will be a naked-eye object in September and October, and it may possibly become extremely brilliant; but it is better not to be too sanguine on this point. The following ephemeris is for Greenwich midnight:—

	R.A.	N.Dec.	Log r.	Log Δ.
	h. m. s.	° ′		
Mar. 5 ...	2 44 2 ...	4 31 ...	0·5343 ...	0·5882
„ 13 ...	2 47 38 ...	6 0 ...	0·5232 ...	0·5904
„ 21 ...	2 52 4 ...	7 30 ...	0·5116 ...	0·5915
„ 29 ...	2 57 13 ...	9 1 ...	0·4996 ...	0·5912
April 29 ...	3 23 48 ...	15 7 ...	0·4492 ...	0·5775
May 29 ...	3 58 36 ...	21 26 ...	0·3935 ...	0·5419
June 28 ...	4 45 36 ...	28 46 ...	0·3271 ...	0·4797
July 28 ...	5 53 6 ...	37 40 ...	0·2507 ...	0·3901
Aug. 27 ...	7 53 12 ...	47 33 ...	0·1643 ...	0·2807
Sept. 26 ...	11 25 20 ...	47 2 ...	0·0819 ...	0·2022
Oct. 26 ...	14 12 4 ...	26 34 ...	0·0435 ...	0·2259
Nov. 25 ...	15 38 0 ...	6 16 ...	0·0822 ...	0·2991

It will be seen that the comet is too near the Sun for visibility in April, May, June. Then it will reappear as as a morning star; but by mid-August it will become circumpolar, and therefore observable all night. It will, however, be best placed just before the dawn. The nearest approach to the Earth will be early in October, the distance being 1·58 astronomical units. On the day of perihelion the comet will be about 7° north of Arcturus. This reminds us of the conjunction of Donati's comet with Arcturus in October, 1858.

THE REMARKABLE QUIESCENCE OF THE SUN.—Mr. E. W. Maunder points out that 1913 was absolutely the quietest year since 1810. The number of days when the Sun was free from spots in 1911, 1912, 1913 was 183,246,310. The mean daily spotted area, measured in millionths of the visible hemisphere, comes out 64, 37, 5 in the three years; the numbers of separate groups are 62, 39, 15; thus in every way activity has declined. The most considerable group appeared on December 30th. Two out of every three of the groups observed last year appear from their high latitudes to belong to the new cycle; the others, being near the Equator, belong to the expiring one. As the new cycle has already been running for one and a quarter years it would seem to promise little in the way of activity.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

SYMBIOSIS BETWEEN ALGAE AND SPONGES.—In the course of a paper on Red Algae from Queensland, Cotton (*Kew Bulletin*, 1913, No. 7) describes some interesting cases of Algae living in symbiosis with sponges. Even in the temperate regions, as on the British coast, carpets of short filamentous Algae are often seen to be in competition with the encrusting sponges which grow in caves and other dark recesses on the shore. In some cases accidental concrescence of the two organisms is observed, in others such association is more constant and intimate. A further and more advanced state of union is met with in the sponge *Halichondria panicea*, which is at times completely invaded by a green filamentous Alga; the external form of the sponge remains unchanged, but infected sponges are recognised by their green colour.

In the tropical seaweed *Thamnoclonium Tissotii*, however, the Alga is the dominant partner, the sponge growing symbiotically on the surface of a large foliaceous thallus. This seaweed, formerly known from the tropical Kei Islands, is now described from Queensland. The thallus consists of large flattened lobes, and both surfaces are completely clothed with a thin sponge, into which penetrate filaments given off from the outer layer of the Alga. The external appearance of the dual organism is that of old faded fronds, but a section shows the sponge with its clusters of projecting spicules.

The seaweed *Ceratodictyon spongiosum* differs from all previously recorded cases of Algae living in symbiosis with sponges in that a change of form is evidently induced through the commensal existence. The main segments of the thallus consist of very slender branches woven together to form a network, the interstices being filled up by the sponge, which also forms an investing coat around each segment. Hence the symbiosis is more intimate than in *Thamnoclonium*, and both organisms are materially modified in habit.

PIGMENTATION AND ASSIMILATION IN PLANTS.—A. von Richter (*Ber. d. deutsch. bot. Ges.*, Bd. 30, pp. 280–290) has made a thorough investigation of the process of assimilation in green, brown, and red Algae at Naples. The Algae were placed in large glass cylinders filled with sea-water of known carbon dioxide content; plants of the differently coloured Algae were exposed simultaneously, some to pure sunlight and others to coloured lights (obtained by interposing spectroscopically-pure coloured screens); while in other series of experiments the assimilation of green, brown, and red Algae in light of varying intensities was determined. At the end of each experiment the water was analysed for carbon dioxide, and the diminution of this gas and the increase in oxygen were noted. From the results the author concludes that the most important factor determining the rate of assimilation in differently coloured Algae is not the colour of the incident light, but its intensity; that among marine Algae, as among ordinary land plants, some species are light-loving and others light-avoiding, or, expressed in terms of Wiesner's *Lichtgenuss* theory, some require a relatively high light intensity and others a relatively low intensity; that the distribution of marine Algae in vertical zones is related to these differences as to *Lichtgenuss* in the different species; that the pigments additional to chlorophyll in Brown Algae (phycophaein), Red Algae (phycoerythrin), and Blue-green Algae (phycocyanin) play no active part in the process of assimilation; that this process is entirely attributable to the chlorophyll which is always present in Algae and all other plants capable of assimilation; and that the well-known and hitherto generally accepted "chromatic adaptation" theory of Engelmann requires thorough revision, since it does not account for, and is indeed rendered unnecessary by, the results obtained in the author's experiments.

VEGETATION ABOVE THE SNOW-LINE IN THE ALPS. Braun (*Ber. d. Naturforsch. Schweiz.*, 1913, 347 pp.) gives an interesting account of the nival (above snow-line) flora of the great mountain masses of South-eastern Switzerland, including the Lepontine Alps in the west, and the Rhaetian Alps in the east. His chief object is to present "a picture of plant life at its extreme limit," and though nearly half of his work, which has also been published in book form ("Vegetationsverhaltnisse der Schneestufe in den Rätisch-Lepontischen Alpen," Georg and Co., Bâle, price 20 marks), is occupied by lists of species with their habitats, he has throughout dealt with the nival zone from an ecological rather than a floristic standpoint. The climatic snow-line, forming the lower limit of the nival zone, lies at about two thousand six hundred and fifty metres in the western (Sardona and Gotthard) region and at about two thousand nine hundred and sixty metres in the eastern (Bernina) region, and the flora of the nival zone in

the area investigated includes two hundred and twenty-four vascular plants. The author divides the plant associations into three main sub-zones :—(1) a lower, up to one hundred and fifty metres above the snow-line, dominated by grasses ; (2) a middle, up to five hundred and fifty metres above snow-line, characterised by Dicotyledons ; and (3) a summit flora devoid of flowering plants and consisting only of Thallophyta (Algae, Fungi, Lichens) which extend up to the highest peaks. Wind is one of the most important factors in the environment of the nival flora, and the author devotes an interesting chapter to the effects on the nival vegetation of the strong winds that prevail in the high Alps, especially in winter. The drying action of these winds excludes all except a few hardy species (*Saxifraga retusa, S. caesia, Androsace helvetica, Gentiana brachyphylla*, and so on) from the snow-free but exposed places. The low-growing tufted, patch-forming, and cushion plants are furrowed, undermined, and distorted by the mechanical action of the wind and the fine snow which it sweeps over the plants as a " snow-blast " comparable with the fierce sand-blast in deserts.

Other interesting sections are those dealing with the ripening, viability, and dispersal of the seeds of nival plants. The author finds that the conditions above snow-line are not so unfavourable for the ripening of seed as has usually been supposed, for in twenty-five species collected above three thousand one hundred metres the seeds were fully ripe and capable of germination, and he believes that the nival flora does not depend to any great extent upon the carriage of seeds from lower levels for its maintenance. Many of his observations are of considerable practical interest to those concerned with the collection and cultivation of alpine plants, though, of course, the great majority of the nival species also occur at lower elevations. In more than twenty per cent. of the nival species the fruits with their seeds remain on the plant over the winter, and in some cases for two or three winters, and the seeds in such cases show a higher germination capacity than seeds collected in the autumn after flowering. Shrubs like *Empetrum, Vaccinium* and *Juniperus* occur here and there in the nival zone, arising from seeds carried by birds, but they are usually dwarfed plants and are always sterile. From various facts and considerations which he brings forward the author concludes that in the Glacial period a relatively rich flora, similar to the nival flora of the present day, persisted in the interior of the Alps; for instance, there are certain nival species which have no special method of dispersal, and which show markedly discontinuous distribution; and these can hardly be regarded otherwise than as relict forms.

VEGETATION OF THE EAST FRISIAN ISLANDS.—Leege (*Abhandl. naturw. Ver. Bremen*, Bd. 21, 1913, pp. 283–327) deals in an interesting manner with what is always an interesting problem to biologists—the colonising of fresh ground by plants. He has for some years investigated the vegetation of the chain of small islands lying off the coast of East Friesland, between the estuaries of the Ems and Weser, and has noted various species, especially among cryptogams, additional to those recorded by Buchenau in his work (1881) on the vegetation of these islands. The paper cited above deals with one of the smallest islands, which is growing in extent and is still in process of colonisation by plants. According to the author's observations, water transport is the most important agent in the colonisation of the island by plants, and an examination of the drift and of the colonising species showed that to a large extent the plants had arisen from vegetative parts carried out to sea—the island investigated (Memmert) lies in the channel of the East Ems—rather than from seeds thus transported. He also considers that wind carriage of seeds has played a very small part, probably limited to the transport of the spores of mosses, ferns, lichens, and fungi, and the seeds of the three species of orchids found on the island. Among the fungi, *Phallus impudicus* is very common : its spores are carried by the butterfly *Vanessa antiopa*. The author ascribes to birds a large part in the carriage of dry as well as fleshy fruits and seeds. In his sketch of the development of the vegetation of Memmert from 1888 to 1912 the author notes that the present flora comprises one hundred and eighty-eight species, while twenty-nine of the early colonists have disappeared.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

WHALE OIL AND ITS UTILISATION.—Until about seven years ago the demand for whale oil was relatively small, for it could only be utilised in the manufacture of glycerin and fatty acids and, to a limited extent, of soap. The objection to its use as the raw material for soap was its persistent odour, which could only be partially masked by the addition of other fats. By the discovery of the process of catalytic hydrogenation this drawback has been obviated, and enormous quantities of the oil are now made into soap. In the catalytic process, an outline of which has already been given in these columns, the oil is heated in a current of hydrogen, in the presence of palladium, nickel, or a similar catalytic metal, with the result that the liquid fatty acids absorb the hydrogen and are transformed into solid odourless compounds resembling tallow, the hardness of the product depending upon the duration of the hydrogenation.

The effect of this discovery upon the output of whale oil is shown by the increased price now obtained. According to Dr. H. Offerdahl-Larvik (*Ber. deutsch. Pharm. Ges.*, 1913, XXIII, 558) the total production of whale oil in 1912 was one million two hundred thousand barrels, more than half of which came from Norway. Ten years ago the cost of producing a ton of the oil was about £13 15s., but last year higher wages and higher prices for fuel had raised the cost to about £19 5s. per ton.

After separation of the oil the residual flesh and bones are dried, ground up, sifted, and mixed in suitable proportions to form an animal manure, containing ten to twelve per cent. of nitrogen and fourteen to fifteen per cent. of phosphoric acid, with about two per cent. of oil. A whale of average size will produce from forty to fifty sacks of such guano, which fetches about 5s. to 6s. per hundredweight. Although it is stated that solidified whale oil is used exclusively in the manufacture of soap, there can be but little doubt that sooner or later it will be employed as a raw material for substitutes for butter and lard. As these hardened oils invariably contain traces of the metal used in the hydrogenation, physiological experiments are needed to ascertain whether minute quantities of nickel or palladium would have any injurious effect upon the system if taken over a long period. According to Dr. Offerdahl-Larvik quantities of 0·5 gramme of nickel could be taken daily without ill effect, while 99·8 per cent. of the metal was rapidly excreted from the system ; but no details are given of the duration of the experiments or of the ultimate fate of the 0·2 per cent. of metal daily absorbed.

PERFUMES OF LICHENS.—Mr. E. M. Holmes, writing in the *Perfumer and Essential Oil Record* (1913, IV, 408), calls attention to the possibility of utilising the odorous principles of lichens in perfumery. For example, the common reindeer lichens (*Cladonia rangifera* and *C. sylvatica*) might be used as the basis of certain perfumes, in the same way as the " oak-moss " (*Evernia prunastri*) is used in France. This lichen usually occurs in association with other lichens, but is readily distinguished by its frond, being grey above and white beneath. It contains a phenol (*lichenol*) which is isomeric with carvacrol (the odorous principle of essential oils of the thyme family), and is soluble in a solution of sodium carbonate.

In France the perfume is extracted from this *mousse de chêne* by means of petroleum spirit, and the solvent is separated by evaporating the extract at a low temperature in a vacuum. The residue is then diluted with a suitable pro-

XUM

portion of alcohol, and incorporated with soap or blended with other essential oils for perfumes. According to Mr. H. Mann (*Amer. Perfumer and Essential Oil Review*, 1913, VIII, 248) the powdered lichen itself is also incorporated with soaps, with the object of imparting its scent and increasing the detergent properties of the preparation. Other lichens containing odorous principles are mentioned by Mr. Holmes. These include *Lobaria pulmonaria*, "oaklungs," *Conocephalus conicus*, which has an odour of bergamot, and *Hygrophorus agathosus* with an aniseed odour, but the essential oils contained in these lichens have not yet been separated and identified.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

PLATINUM METALS IN CUPELLATION BEADS.—The influence of small quantities of metals of the platinum group on the appearance of silver and gold buttons obtained by cupellation forms the subject of an interesting paper read before the Institute of Mining and Metallurgy by Messrs. C. O. Bannister and G. Patchin. (Through *Journal of the Society of Chemical Industry*, 1914, page 29.) Photographs of the surfaces of the buttons, taken under low magnifications, show that the characteristic appearances are clear and pronounced. Platinum, iridium, rhodium, and ruthenium all give rise to characteristic effects. Palladium gives results similar to those produced by platinum, but the presence of the former is very clearly revealed in the parting operation, as little as 0·0002 gramme of palladium imparting a yellow tint to the parting acid. Osmium, however, even when present to the extent of two per cent., has no effect on the appearance of the silver bead.

POROSITY OF IRON.—In the January number of *The Journal of the Chemical Society* Mr. W. H. Perkins describes the results of experiments designed to test the truth of the view that iron which has been immersed for some time in a solution of alkali hydroxide, and then thoroughly washed with water, still retains a small quantity of alkali in its pores. In addition to positive tests obtained with iron foil, the author found that a gold crucible which had contained lithium hydroxide for some months, after washing well for five or ten minutes with running water, required a daily change of water for more than four weeks before the spectroscopic test for lithium failed to show its presence in the water. From his experiments the author considers it is clear that traces of alkalis, and presumably, therefore, other solutions, are retained by metals in such a way that their extraction is a slow process of simple diffusion, and cannot be hastened by shaking or even by gentle rubbing. Whether this is due to actual porosity, or to the formation of a surface layer, is not quite clear, but the "absorption" is obviously very slight.

THE FUTURE OF OIL FUEL.—In his presidential address to the Junior Institute of Engineers, Sir Boverton Redwood discussed the probable development of the use of oil fuel. The demand which will have first to be met will be that of the belligerent navies of the world, since to them efficiency, rather than cost, is of paramount importance. The industrial use of oil fuel will depend to a large extent on the development of the internal combustion engine, since with the steam-engine not more than twelve per cent. of the energy of the fuel is ordinarily obtained in the form of work, whilst in the case of the Diesel engine the return is as much as thirty-seven per cent. Though in the use of oil for steam raising the consumer can afford to pay about twice as much for oil as he pays for coal, in view of the higher thermal efficiency of oil and other advantages attaching to its use, yet in the light of present knowledge it would be wrong to suggest that the supply can ever become so abundant as to give consumers in general a free choice in substituting oil for coal as a source of power. Sir Boverton Redwood concluded his address with a strong appeal for the economic and scientific exploitation of oilfields. Millions of pounds sterling have been thrown away in haphazard drilling operations, and valuable oilfields have been destroyed by reckless procedure. The petroleum industry presents unusual difficulties, and demands genius for its most successful conduct. It is gratifying to learn that various educational institutions, including the Royal School of Mines, are giving special attention to the training of students in the technology of petroleum.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE IMPERIAL ANTARCTIC EXPEDITION.—Through the medium of the daily Press the public is already familiar with the outline of the plans which Sir Ernest

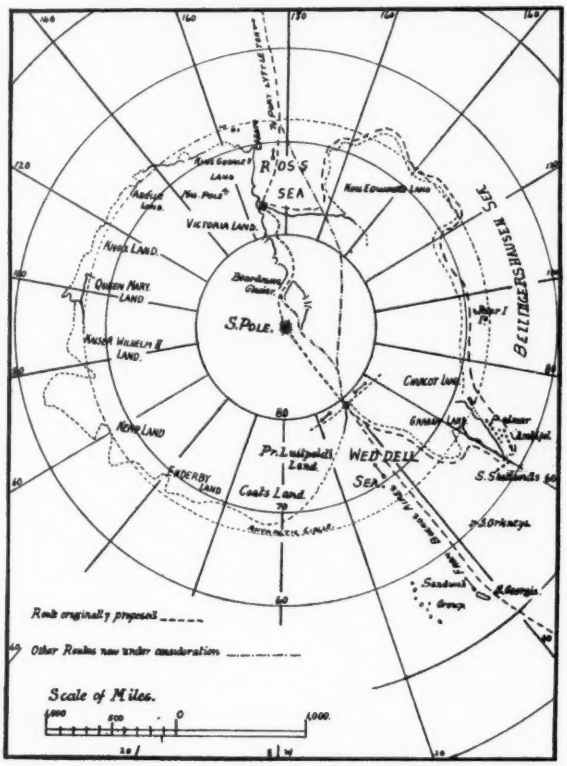


FIGURE 99.

Sketch map for showing the routes proposed for the Imperial Antarctic Expedition.

Shackleton has proposed for his new Imperial Antarctic Expedition. We print a map (see Figure 99) to illustrate the routes under consideration — that originally proposed and those others which have been suggested by eminent geographers, and which Sir Ernest will regard as alternatives.

The plans for the new expedition have been welcomed in the scientific world. While the main object of the leader is to accomplish a traverse of the Antarctic Continent, and thereby settle the question of the existence of a polar land-mass, scientific interest centres also round two other points. The expedition will determine the extension of the range of mountains which crosses Victoria Land; in particular, whether it reaches the Pole, and whether there are mountains continuing this chain or independent of it on the Weddell Sea side. It has been suggested that the Andes have there a southward extension in Antarctica. The obtaining of definite information on the matter is of considerable interest and importance. The second point is the meteorology of Antarctica. Here again many deductions have been based on what is known of the more accessible parts of the globe and applied to polar regions. The conditions

obtaining there are, as it were, boundary conditions for the terrestrial system, and actual verification or correction of the assumptions made regarding them is of prime importance. The scientific staff will include at least four geologists, and personnel and equipment will be provided for valuable work on biology, oceanography, magnetic observation, and surveying. We hope that public liberality towards this expedition will not await the stimulus of misfortune, and if it does, that it will wait in vain. The greater the financial support, the greater and more valuable the work that can be undertaken.

THE INTERNATIONAL 1:1,000,000 MAP OF THE WORLD.—In the last four years some dozen sheets of this map have been prepared, and a recent congress met at Paris to consider the undertaking in the light of the experience so gained. The unanimity of the representatives of geography, to which is due the inception of the map, is one of the most pleasing features of their deliberations. Several modifications of the plans adopted in London in 1909 have been introduced. The uniform contour interval of one hundred metres was found to be inconvenient. Contours at two hundred metres, five hundred metres, and above that at intervals of five hundred metres will appear in all maps as continuous black lines, and contours at one hundred-metre intervals, where found practicable, as interrupted lines. The colours used to indicate the relief will still change at intervals of one thousand metres on the higher ground, but the browns will pass into carmine instead of magenta. Colouring will stop at the snow-line, and glaciers will be indicated in blue. China has undertaken the production of the maps of Chinese territory. A permanent office will be established in Great Britain for the purpose of issuing an annual report and circulating information and useful data. It is gratifying that the representatives of the various countries were sent duly accredited by their Governments, and that they will present the proposals of the Congress to these for formal ratification.

A NEW STREAM TYPE.—In an interesting article in a recent number of *The Journal of Geology* Mr. C. R. Keyes describes the action of wind-scour in modelling the complete topography of desert regions. The example cited is the northern Mexican tableland. This region underwent planation and uplifting before its climate became arid. Its topography cannot be the result of normal stream erosion on recently upraised orogenic blocks, for the profound faulting in the area took place in very ancient times. The dissection of the plateau is ascribed to the differential action of deflation on the weak and resistant beds which respectively form the main body of the upper and lower parts of the rock sequence in northern Mexico. The process has given the mountains an aspect characteristic of the early stages of stream erosion. The existence of a scanty rainfall is held to be actually due to the aridity of the region. As wind erosion under arid conditions imparted unevenness to the ground, it acted as a provoker of rain. The streams thus produced increased in size slowly as the relief of the ground became more marked, but they are doomed to reach a circumscribed maximum of size and efficiency, and have no ancient connection, like normal streams, with a primaeval drainage system.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE GEOLOGY OF SOUTH GEORGIA.—South Georgia is a remote island lying in Antarctic waters to the south of the Atlantic Ocean, about nine hundred miles south, eighty degrees west, of the Falkland Islands. It has recently been visited by Mr. David Ferguson under the auspices of Messrs. Chr. Salvesen & Co., of Leith, the well-known shipowners, who have a whaling station on the island. An account of the geology of the parts of the island visited by him is contributed by Mr. Ferguson to the February *Geological Magazine*, with an appendix on the petrology by the present writer, and a paper on the geological relations of South Georgia by Professor J. W. Gregory, F.R.S. South Georgia is a narrow elongated island, one hundred and ten miles long, with a greatest width of twenty-three miles. Its longitudinal axis is a mountain-range whose highest point, Mount Paget, rises eight thousand three hundred and eighty-three feet above sea-level. The central range is covered with permanent snow and ice, from which glaciers sweep down the main valleys to the sea. Geologically South Georgia appears to consist mainly of sedimentary rocks which are highly indurated, folded, and in places metamorphosed. These are mainly greywackes, slaty grits, mudstones, shales, and slates, passing into phyllitic grits and phyllites with increasing metamorphism. Interbedded with this series are sparse gritty limestones and more abundant tuffs. The latter are composed of mineral fragments and rock-chips of dominantly trachytic lava. They are in general remarkably fresh, but in some places have undergone sporadic scapolitisation. Mr. Ferguson divides the sedimentary succession in South Georgia into the Cumberland Bay Series, with Upper, Middle, and Lower Divisions, which unconformably overlie an older Cape George Series.

The geology of South Georgia is of special interest, since it promises to throw light on the geological history of the southern ocean to the south of the Atlantic, and on the tectonic relations of South America to West Antarctica. According to Suess, South Georgia is a part of a great loop-like continuation of the Andes, which, bending eastwards in Tierra del Fuego, continue thirty degrees to the east, through South Georgia, and then returns through the South Sandwich Islands and the South Orkneys to Graham Land. This loop may be considered homologous to that which forms the Antilles and unites North and South America.

Despite the new information, however, the evidence afforded by the rocks of South Georgia on this question remains indecisive. Certain fossils, unfortunately rare and often fragmentary, have been found in the Cumberland Bay Series. A *Posidonomya*, probably Cretaceous, was found by the Swedish Antarctic Expedition, and an ammonite, identified doubtfully as an *Acanthoceras* by Professor Pompeckj, was found by the German Antarctic Expedition of 1911, led by Lieutenant Filchner. A number of fossils were also found by Mr. Ferguson. Some of these are fucoidal; others may be much-crushed simple corals, resembling *Omphyma*. A few of radiolaria were found during the microscopic study of the rocks, and these have been identified by Dr. Hinde, who concludes that they are post-Palaeozoic and pre-Tertiary, and might come in between the Triassic and the Cretaceous. The evidence for the age of these rocks is therefore poor, and even contradictory. According to Professor Gregory, the palaeontological evidence suggests the Palaeozoic age of the Lower Division and the Mesozoic age of the Middle and Upper Divisions of the Cumberland Bay Series. The evidence of the igneous rocks of the island is no less ambiguous. The interstratified tuffs are not of Andean type; and although an "altvulcanischer" basaltic area and granitic and dioritic rocks (occurring as blocks in the moraines) have been described by Fr. Heim in the eastern part of the island, no definite evidence exists at the present time to correlate these rocks with the typical products of Andean igneous activity.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

UPPER AIR RESEARCH.—Mr. C. J. P. Cave in his Presidential Address at the Annual Meeting of the Royal Meteorological Society dealt with the subject of upper air research. He pointed out that research in the upper air may be by means of manned balloons with observer and instrument, or by self-registering instruments sent up in

kite, captive balloon, or free balloon. Kites were first used for this purpose by Dr. Wilson of Glasgow, 1749; and also in Arctic expeditions in 1832 and 1836. The box kite and the use of steel piano wire instead of cord enabled greater heights to be obtained, and both were adopted by Professor Rotch at the Blue Hill Observatory in 1895. The use of kites for meteorological investigations was not taken up in England until 1902, when Mr. Dines flew them from a steamer off the west coast of Scotland.

After referring to the use of balloons and the ascents made by Glaisher and others, Mr. Cave said that danger to life in high ascents caused MM. Hermite and Besançon to use a registering balloon in 1893; a free balloon carried a recording instrument, the recovery of the instrument being dependent on the balloon being found after its descent; a height of nine miles was reached in France and thirteen and a half miles in Germany soon after. Reference was made to the various types of instruments used in the research, and a description given of Mr. Dines's meteorograph, which is an extremely simple and light instrument. Rubber balloons are usually used, and as they ascend they tell of the winds above the surface. A special theodolite is used for observing the balloons.

Ingenious pieces of apparatus have been invented for upper air research. The latest is that by Dr. Assmann, which is intended to measure the temperature of the air over the sea, desert countries, or in Arctic or Antarctic regions when there is little chance of recovering the balloon. The balloon is watched through theodolites, and its height from minute to minute is calculated in the ordinary way. An arm attached to a thermometer completes an electric circuit at a predetermined temperature, say at freezing-point; the electric current explodes a firework hung below the balloon, and the observer sees a puff of smoke as soon as his balloon has entered a layer of air in which the temperature is at freezing-point. Other fireworks can be exploded in turn at predetermined temperatures, and it can be arranged that the fireworks connected with the various temperatures should show smoke of various colours, so that in the event of any particular firework accidentally failing to explode the colour of the next puff of smoke will show the temperature.

The International Commission for Scientific Aeronautics directs the studies of upper air research and special days are arranged for the international ascents of balloons and kites. Stations in various parts of the world now take part in the work.

The first great result of these researches has been the discovery that the atmosphere is divided into the troposphere, where the air is in constant movement, horizontal and vertical, and the stratosphere, where turbulent motion seems to cease. The stratosphere begins at about seven and a half miles in these latitudes. The method of investigation is new, but many other results are beginning to come to light, and it seems possible that the changes in the atmosphere to which our changes of weather are due, originate not at the surface of the Earth, as was formerly supposed, but in the layer of the atmosphere just below the stratosphere—or about seven miles up.

SIX RAINBOWS SEEN AT ONCE.—Mr. A. H. Waller in a communication to the *Quarterly Journal of the Royal Meteorological Society* states that on November 5th, 1913, a little previous to the Sun disappearing behind the mountains, he noticed at Umtali, Rhodesia, in the east, six brilliant rainbows extending for about one-quarter of the semicircle. Five were quite close together, and the sixth some little distance away.

METEOROLOGICAL CONFERENCE AT EDINBURGH.—The want of effective opportunity for discussing in conference the various aspects of the physical sciences in their application to the study of the phenomena of weather has long been felt, and it has been suggested that as there will be no meeting of the British Association in this country in 1914, it would be desirable to organise a Conference with that object. Upon the invitation of the Scottish Meteorological Society it is proposed that the Conference should take place in Edinburgh on Tuesday, September 8th and four following days. The mornings will be devoted to the discussion of scientific subjects connected with the study of the atmosphere. The afternoons will be available for demonstrations; lectures are to be arranged for two evenings and a reception for another. On the Saturday there will be excursions to some places of scientific interest.

The scope of the papers to be discussed will include the physical and observational aspects of Meteorology, Climatology, Oceanography, Limnology, Atmospheric Electricity, Terrestrial Magnetism, and Seismology. One of the objects of the Conference will be to bring together observers in these departments of science and those interested, from the theoretical point of view, in the discussion of the observations. To meet the necessary expense, the subscription for members of the Conference has been fixed at ten shillings; tickets of admission for ladies accompanying members will be issued at five shillings. All those who wish to join the Conference or who desire further information are requested to communicate with the Hon. Secretary of the Committee at the Meteorological Office, South Kensington, S.W.

MICROSCOPY.

By F.R.M.S.

THE TWIN MICROSCOPE.—Devices enabling one observer to view two objects conjointly have been adapted to the microscope in various forms. In all these arrangements prisms are employed to project the images formed of two objects into the field of view of one and the same eyepiece. The first two devices contrived for this purpose were employed for comparing the images formed by two independent microscopes.

An instrument of this kind, called a "Comparison Chamber," was first described by Inostranzeff in the "Neues Jahrbuch für Mineralogie," 1885, Vol. II, pages 94–96. It was designed for the microscopic examination of opaque minerals. The instrument took the place of the eyepieces and connected the two microscopes in bridge-fashion. A similar apparatus fitted with a different prism arrangement was at the instigation of Van Heurck made by C. Reichert, of Vienna, for the comparison of diatoms. He called this apparatus an *Oculaire Comparateur*, or "Comparison Eyepiece," and described it in his work "Le Microscope," page 101. In the two following arrangements, both of which serve the same purpose, the two microscopes form part of the same stand. A microscope of this kind, as devised by Ewell, will be found described and illustrated in the *Journal of the Royal Microscopical Society*, 1910, page 14. In Ewell's arrangement two microscopes are mounted side by side on one stand, so that there is only one foot, upright, stage, and focusing mechanism. The image formed by either objective is reflected into the eyepiece with which it is associated through the medium of a prism of rhomboid cross-section. Recently a very similar instrument, called a "Comparison Microscope," has been made by Seibert at the suggestion of Thorner, as described in *Mikrokosmos* (Vol. VI, 1911–12, page 123) and discussed by Wychgram in *Zeitschrift f. wiss. Mikroskopie*, XXIX, 3.

The new instrument as shown in Figure 100, which we will call a "Twin Microscope," differs in its optical arrangement considerably from those already referred to. Unlike these, the twin microscope is a binocular arrangement of two microscopes mounted on one stand, each being provided with its own complete optical equipment in the way of a mirror, illuminating apparatus, objective, and eyepiece. The stage is large enough to accommodate two preparations. Both body tubes are rigidly connected, and are displaced jointly by a rack and pinion coarse focusing adjustment, whilst the slow movement is by means of a fine screw fitted to either tube between the latter and the objective. The

distance between the eyepieces is adapted to that between the eyes after the plan adopted in the microscopes of the Greenough pattern, and, as in the latter arrangement, the images are rendered erect by the aid of Porro prisms. Both the eyepiece drums surmounting the tubes which contain the Porro prisms and oculars are movable, and by this means it is possible to displace the optical axes of this part parallel with one another and to set the interpupillary distance for each observer, as shown in Figure 101.

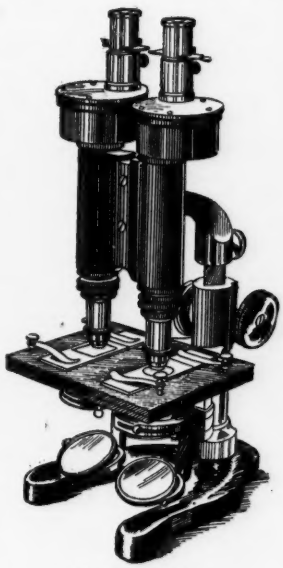


FIGURE 100.
The Twin Microscope.

Both eyes of the observer receive by this means an impression of the two images, more or less superimposed, by virtue of a remarkable property of the eyes which causes an image seen by one eye to transmit itself to the other eye through the agency of a central nerve station. As a rule, these images are dissimilar. If they do not interfere with each other, and if the objects appearing in the field of view can be so arranged in position on the stage that one object may occupy a place in an unoccupied part of the field of view containing the other object, it will be easy to compare the two objects. Where, as is most often the case, the nature of the objects does not admit of this being accomplished, one half of either field of view should be cut off by means of the semicircular stops situated in the plane of the eyepiece diaphragm in such a manner that the other two semicircular halves may fuse into a complete circular field within which the two objects, separated by a scarcely perceptible line, can be seen side by side and compared. To view in rapid succession the two entire circular images the stops should be opened and closed alternately on the right and the left. This twin arrangement, by which the objects may be seen side by side in the same field or their entire fields viewed in rapid alternation, furnishes an excellent and convenient means of comparing healthy and pathologically modified tissues and adulterated and normal foodstuffs, and so on. It may be used with advantage for demonstrating side by side the distinctive characteristics of two allied objects. Also with this arrangement the same object may be shown under different magnifications, or it may be viewed by transmitted light or the method of dark-ground illumination, and by ordinary or polarised light. The instrument is also available for the examination of minerals illuminated by incident light, for which purpose Inostranzeff devised his "Comparison Chamber." Moreover, for examining and comparing two minerals by polarised light both optical equipments may be supplemented by the necessary adjuncts for mineralogical investigations. Also, the instrument is adapted for the colorimetric and spectroscopic examination of blood, which was the original purpose for which Ewell devised his arrangement. It is also probable that in many instances the instrument may be used for comparing the numbers of blood corpuscles contained in two preparations, thus dispensing with the necessity for a carefully conducted count. The instrument differs from others devised for similar purposes, in that it is available for stereoscopic observations. It can be used in this way with particular advantage where an observer is able to produce greatly reduced stereoscopic pictures of large objects, as the twin microscope provides an excellent means of viewing these in relief magnified to the natural size of the object. The Twin Microscope is made by Messrs. E. Leitz, of Wetzlar, and 18, Bloomsbury Square, London, W.C.

C. METZ.

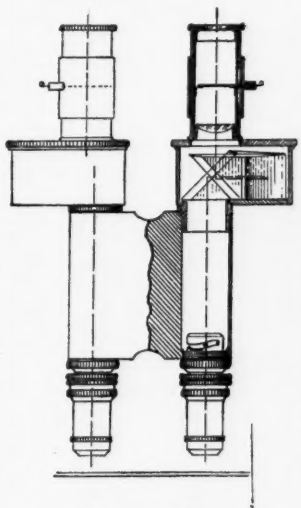


FIGURE 101.

THE QUEKETT MICROSCOPICAL CLUB.—At a meeting of the Quekett Microscopical Club, held on January 27th, Mr. S. C. Akehurst read a paper on "Some Observations concerning Substage Illumination." The paper described the several advantages to be obtained by the use of a reflecting condenser in resolving fine diatom structure. the Leitz concentric model being the one employed. A number of photomicrographs by Mr. T. A. O'Donohoe in illustration were thrown on the screen. Mr. T. A. O'Donohoe discussed "An Attempt to Resolve *Pinnularia nobilis*." This referred to the fine lines between the costae which a two-millimetre apochromat of N.A. 1·3 failed to resolve into dots when used with an immersion condenser and central cone, but on substituting the reflecting condenser referred to above a resolution was obtained of which a photomicrograph was exhibited.

PHOTOGRAPHY.

By EDGAR SENIOR.

SODIUM THIOSULPHATE ("HYPO").—From the time when Sir John Herschel first described the solvent power of what were termed "the alkaline hyposulphites" upon chloride of silver, the substance employed by the photographer in fixing his negatives and prints has invariably gone by the name "hyposulphite of soda," in spite of the fact that the name is not correct from the constitution of the substance. It may, however, be considered that this is of little importance to the photographer, since the name has become by long-continued use so thoroughly established that there is very little chance of any confusion arising. However, the name "hyposulphite of soda" really signifies a sodium salt derived from a sulphur acid containing less oxygen than sulphurous acid, or less oxygen in the molecule than a sulphite; and in the case of a sodium compound such a substance would have the formula Na_2SO_3. So long as this salt remained unknown, however, no confusion could possibly arise, but when, owing to the work of, Professor Schutzenberger, this body came into existence, it became necessary to assign a name that should correctly express the constitution of the substance used by the photographer as a fixing agent. On this account chemists now call the "hypo" used by the photographer "sodium thiosulphate," a name which has reference to its composition, showing that it is derived from a sulphur acid (sulphuric) in which an atom of oxygen has been replaced by sulphur, the prefix "thio-" being derived from the Greek θεῖον sulphur; thus sodium sulphate having the constitution

$$SO_2\begin{cases}ONa\\ONa\end{cases} = Na_2SO_4$$

sodium thiosulphate becomes

$$SO_2\begin{cases}SNa\\ONa\end{cases} = Na_2S_2O_3.$$

This salt is therefore a derivative of thiosulphurous acid,

a body which, however, has not been obtained in the free state. Thiosulphates, like sulphites, are readily oxidised, but under certain conditions they yield oxygen to more powerful reducing agents, and thus themselves become oxidising agents. Sodium hypochlorite, ferric chloride, free chlorine, and so on, completely oxidise thiosulphates to sulphates, even in a cold solution; thus ferric chloride gives with sodium thiosulphate a violet-coloured solution at first, which, however, on standing is slowly decolorised, the ferric salt being reduced to ferrous, thus:

$$Na_2S_2O_3 + 4Fe_2Cl_6 + 5H_2O = 2NaHSO_4 + 8FeCl_2 + 8HCl.$$

Thiosulphate of soda, which is a white crystalline substance containing about forty per cent. of water of crystallisation, is chiefly of interest to photographers as a means by which the unaltered silver salts in their negatives and prints may be readily decomposed, an operation technically known as "fixing." And, although the thiosulphate is very readily soluble in water, recent researches of MM. Lumière and Seyewetz go to show that there is great difficulty in completely removing it from prints by simply washing. Experiments conducted by these investigators showed that when a solution of thiosulphate of soda has been used for fixing a certain number of prints, and consequently contains dissolved in it an appreciable quantity of soluble silver salts, any further prints treated in the same solution cannot be completely freed from all traces of "hypo," however prolonged a washing may be given to them, as in all cases it was found that prints so treated exhibited a brown stain when treated with a solution of silver nitrate used as a test for the presence of "hypo." As a possible explanation of the difficulty of entire removal of the fixing solution by washing in water MM. Lumière and Seyewetz think that probably the double thiosulphate of silver and sodium, which is formed during the time that the print is in the fixing bath, may undergo some change, with the result that thiosulphates are formed which are less soluble and incapable of removal by means of the combined action of water, aided by pressure exerted with a squeegee, as experiments carried out with P. O. P., bromide, gaslight, collodio-chloride, matt albumen, and prints toned in a combined toning and fixing bath all showed, even when the fixing bath had only been used for a very small number of prints, and these had been very thoroughly washed, that sufficient thiosulphate compounds still remained to produce the characteristic reaction with the silver nitrate test. It was found that of twenty prints toned in a combined toning and fixing bath, and afterwards washed for twenty-four hours, the whole of them still contained enough "hypo" to give a strong brown stain with silver nitrate. A similar number of prints treated in another portion of toning and fixing solution showed that in the first two prints only could the "hypo" be removed completely by washing, and from the third print onward silver nitrate produced stains which were more pronounced the more the bath had been used. As a means to prevent this, and ensure the complete removal of "hypo," MM. Lumière and Seyewetz made use of two fixing baths, the second following after sufficient washing to remove the greater part of the "hypo" of the first. They thus recommend that prints shall be placed in the usual fixing bath, and allowed to remain for five minutes, after which they are to be washed for one hour, and that at the end of every fifteen minutes the prints shall be drained and as much of the solution as possible pressed out with a squeegee, and the washing again continued. At the expiration of one hour the prints are to be placed in a second fixing bath of the following strength:—

"Hypo"	...	...	...	4 ounces
Water	...	...	...	20 ,,

and allowed to remain in this for five minutes, after which they should be again washed for a period of from one to one and a quarter hours, when a drop of the silver nitrate test solution applied to a print should not produce any appreciable colour after the lapse of two or three minutes. When a considerable number of prints have been fixed in the second bath it may be taken in use as the first, and a fresh one made up in its place. The idea of a second fixing bath is not a new one entirely, as the desirability of such a procedure was pointed out by Sir William Abney many years ago in order to ensure perfect fixation of prints.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

THE TUBE OF THE PISTOL CRAB.—R. P. Cowles describes the way in which *Alpheus pachychirus* of the Philippines makes its tube of matted alga-threads. The tubes are often twenty-five to thirty centimetres long and two centimetres in diameter, and one end is fixed to the rock. A male crab placed on a piece of matted alga turned itself on its back, and, using the slender chelate limbs immediately behind the forceps, drew the sides of a furrow together and sewed them by a simple stitching. Threads of alga were drawn from each side into the opposite side. On another occasion a tube was torn into shreds and given to a pair of crabs, which made a coherent tube by next morning. Filaments were entangled on the edges of a sheltering piece of rock and then drawn together. "When the alpheus found a hole in the rapidly forming tube the slender legs came through, caught hold of the filaments of the alga, and manipulated them in much the same manner as a man might the thread with which he darns a hole in his sock; that is, by drawing the edges of the hole together and fastening them."

LICE ON SEALS.—One would not expect animals so much in the water as seals to be infested with lice, and yet they have their peculiar pests. Thus Mr. William Evans reports *Echinophthirius phocae* (Lucas) from the common seal (*Phoca vitulina*) shot at the Isle of May in the Firth of Forth. The seal was so terribly infested that forty-three lice were taken off one square inch, and every hair had one or more eggs attached to it. Mr. Evans notes that the thick coating of stiff hairs on the louse no doubt serves to retain a supply of air for respiration while its host is under water.

INHERITANCE IN SHORT-TAILED AND TAILLESS DOGS.—Philippe de Vilmorin has made a number of crosses between dogs with normal tails and dogs with short tails or none. Out of one hundred puppies fifty-two were normal and forty-eight had short tails or none. From two normal parents of pure race only long-tailed puppies are got. Short-tailed or tailless parents give a progeny with a certain proportion of long-tailed forms. It appears, therefore, that the long-tailed forms are homozygous and recessive, and that the short-tailed or tailless types are heterozygous. It need hardly be said that cases of artificial curtailment have to be carefully excluded. There is no transmission of that mutilation in any degree.

ENDURANCE AND LONGEVITY OF FLEAS.—Socrates asked how far a flea could jump, but it is even more important to know how long it can live. It is important because fleas are bearers and disseminators of various parasites (among Bacteria, Protozoa, and even Helminths); thus the rat-flea of India (*Xenopsylla cheopsis*) is the bearer of the plague microbe. The British rat-flea (*Ceratophyllus fasciatus*) usually passes through its developmental cycle in two to three weeks; in ten days in warm, damp weather. Gautier and Raybaud kept one alive on human blood for ninety days. Another lived for forty-one days in an ice-chamber without feeding. Dr. William Nicoll finds that a rat-flea can live on an average about a week apart from its host. The period of survival is longer at low temperature and in the light; it is shortened by excess of dryness or by excess of moisture. Very important, however, is the discovery that the larvae and pupae may survive in infected material (grain, sawdust, brushings, and so on) for so long as a year.

TWO KINDS OF MALES IN A SPECIES OF SPIDER.—Dimorphic males are well known in some insects and crustaceans, but there are few instances among spiders.

XUM

Dr. T. S. Painter has recently studied the case of a North American species, *Maevia vittata*, where two kinds of males occur, "the tufted" and "the grey." The Peckhams mention another Jumping Spider, *Zygoballus bettini*, in which there are large and small males. The tufted males of *Maevia vittata* differ from the greys (which are like the females) in the colour of the legs, in the colour of the palps, and in the possession of three tufts of hairs on the cephalothorax. Now it is exceedingly interesting to find that the two forms differ also in the method of their "love-dance" before the females, and in a minute cytological detail. It was found that the nuclei of the cells of the greys carried a pair of chromosomes which the tufted males lacked. The females showed no preference for either type. We have probably to do with a mutation on which selection has not operated. The numbers seem to be approximately equal.

THE LIVING OKAPI.—M. Wilmet has made some observations on this rare inhabitant of the mountainous forests of the Congo. He kept one alive for a month at Wamba. It is an extremely clean animal, and licks itself like a cat. It is very timid and dislikes the light of day. It travels and feeds by night. The leaves of young branches form its chief food. A pair and a young one may be seen together, but never more. The minute horns are confined to the males. M. Wilmet's captive was a young one, which he fed chiefly on goat's milk. It became tame and would come when called. Unluckily, however, on the twenty-fourth day it went off its food, and died three days afterwards.

DEVELOPMENT OF A RABBIT'S EGG CONTINUED OUTSIDE THE MOTHER.—Professor A. Brachet has made the very important experiment of removing the developing egg of the rabbit on the sixth or seventh day, while it is still a blastodermic vesicle, with no differentiation beyond the establishment of the germinal layers, and placing it with many precautions in a clot of plasm prepared from the rabbit's blood. The germ not only survived for twenty-four to forty-eight hours in this artificial medium, but exhibited progressive development. It differentiated normally into an embryonic portion, the beginning of the placenta, and a "papilliferous zone." The daring experiment shows that the inherited nature embodied in the organisation of the germ can express itself for a time in conditions of nurture very different from the normal.

REMARKABLE CYPRINODONT FISH.—C. Tate Regan describes a minute fish, about an inch long, from Johore, in which the males are distinguished by the possession of a relatively large and very complex intromittent, or inseminating, organ. It is quite unlike any other organ of the kind, and there are several associated peculiarities, such as the length of the male duct or vas deferens, and the wide separation of the genital and urinary apertures. It is remarkable to see such a relatively large amount of complex structure specialised in a tiny fish for reproductive purposes. The name *Phallosthethus dunckeri* is proposed for the new type.

SOLAR DISTURBANCES DURING JANUARY, 1914.

By FRANK C. DENNETT.

CONDITIONS were very poor for making solar observations during January, the Sun not being seen at either station on nine days (4th, 8th, 9th, 13th, 15th, 19th to 21st, and 30th). On seven days (14th, 17th, 24th, 25th, 27th, 28th, and 31st) the disc appeared free from disturbance. Dark spots were observed on five (1st to 3rd, 5th and 7th) and faculae on the remaining ten. The longitude of the central meridian at noon on January 1st was 228° 38′.

Nos. 20 and 21 of December, remaining visible until January 3rd and 2nd respectively, both reappear on our present chart with the faculic surroundings of the former, which remained visible until the 6th.

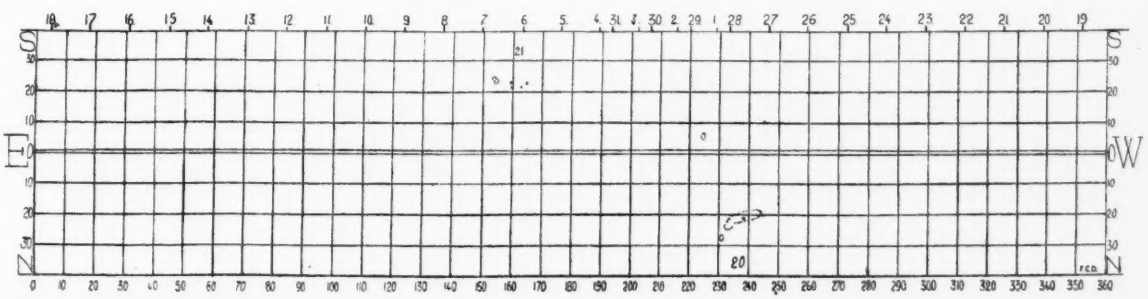
On the 5th a penumbraless spot was seen, but not measured, in high northern latitude, about nine days on the disc, and therefore not far from longitude 201°. At the same time a pore was seen in medium south latitude some six days on the disc—and so near longitude 162°—which makes it probable that it was in some way connected with the disturbance No. 21.

On the 7th, in fairly high northern latitude, about nine days on the disc, which would be near longitude 175°, there were two small penumbraless spots.

A small facula on January 2nd, seen at longitude 153°, S. latitude 24°, a little east of No. 21. The fine group seen on the 5th and 6th near the north-west limb marked the position of No. 20. On the 7th a facula was observed near longitude 224°, S. latitude 6°, near the western limb. Also near the western limb on the 10th, and so about in longitude 200°. On the 11th and 12th a fine faculic area was closing up to the south-west limb; clouds and snow prevented measurements, but it was doubtless the remains of No. 21. On the 16th a faculic disturbance near the south-west limb, probably between longitudes 100° and 110°. On the 18th a faculic disturbance some two days within the eastern limb, near longitude 300°. On the 22nd faculae were recorded within the north-eastern and south-eastern limbs; the former in longitude 237°, was probably a remnant of No. 20. A bright knot, amongst fainter ones, seen on the 23rd at longitude 231°, N. latitude 27°, and also a small one in south polar regions. On the 26th a small faculae seen in the south polar region, and also near the south-east limb. On the 29th a small facula in the south-east at 154°, 23° S.

The note and chart is prepared from the observations of Messrs. John McHarg, C. P. Frooms, J. C. Simpson, and the writer.

DAY OF JANUARY, 1914.



NOTICES.

THE PEOPLE'S BOOKS.—Among the forthcoming People's Books is one on " Wild Flowers," by Mr. MacGregor Skene, B.Sc., which will be very fully illustrated.

THE INCURSION OF WAX WINGS.—*British Birds* for March contains several pages of notes on " The Incursion of Wax Wings " into the British Islands during the past winter, which are supplementary to those already published in the February number.

MESSRS. A. & C. BLACK'S SPRING LIST OF BOOKS. —This catalogue contains several works dealing with medical science, and some natural history books, including " Common British Beetles," by the Rev. Charles A. Hall, which is the twelfth in the " Peeps at Nature " series.

THE JOURNAL OF MICROLOGY.—Our readers will be interested in hearing that the Postal Microscopical Club is now issuing a printed magazine called *The Journal of Micrology and Natural History Mirror.*—The publishing offices are 22, Carnarvon Road, Reading, and the subscription is 3/6 a year, including postage.

NEW LANTERN SLIDES.—Messrs. Flatters & Garnett's supplementary catalogue of lantern slides contains those which have been added to their list during the year 1913. Among them are a large number of photographs of British wild flowers and a series dealing with commercial geography produced by Dr. N. Wilmore.

THE FARADAY HOUSE JOURNAL.—The issue of *The Faraday House Journal* for Lent term has reached us. It is edited by Mr. E. A. Nash, the Secretary of Faraday House, and, besides containing much information of particular value to the students of that Institution, it includes interesting notes and articles on engineering subjects, particularly with regard to electricity.

BOOKS ON GARDENING.—Considerably more than a thousand titles are included in the " Gardening Catalogue " which Messrs. John Wheldon & Company have sent to us. We notice that Pennant's copy of Miller's " Gardener's Dictionary " is included under the heading " Early Gardening and Husbandry," and that inserted in it are some interesting lists of fruit trees, heaths, and seeds.

BIBLIOGRAPHY OF ASTRONOMICAL STUDIES.— The Royal Observatory of Belgium has issued an appeal to astronomers to send in details with regard to the personnel, instruments, research work, and publications of the various observatories throughout the world, in order to make as complete as possible a second edition of " Les Observatoires Astronomiques et les Astronomes."

BRITISH-MADE X-RAY TUBES.—We are pleased to call attention to Mr. C. H. F. Muller's catalogue of X-ray tubes manufactured in England, and to mention the coloured plates, in all cases taken from actual photographs of Muller Tubes, which should be of much use to workers when judging of their appearance. The catalogue contains much information as to the selection and manipulation of the tubes.

LECTURES AT THE HORNIMAN MUSEUM.—The following lectures will be given free on Saturday afternoons in the new Lecture Hall in the Horniman Museum, Forest Hill, at 3.30 p.m.: March 7th, " Parachuting and Flying Animals," Mr. H. N. Milligan, F.Z.S. (Zoölogist at the Museum); March 14th, " Bygones," Mr. Edward Lovett; March 21st, " Makers of Soil," Dr. E. Marion Delf; March 28th, " Magic and Fetishism in West Africa," Mr. A. R. Wright.

THE CAMBRIDGE BRITISH FLORA.—The publication of the new and important " British Flora," written by Dr. C. E. Moss with the help of a number of specialists, will be begun on March 18th with Volume II (Dicotyledonous families, such as poplars, willows, oaks, and elms, as well as docks, goosefoots and glassworts). The work will be completed in about ten volumes; the price was raised on February 16th from £2 5s. to £2 10s. each. Subscribers to the whole series will now pay £2 5s. per volume instead of £2.

INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE.—We would remind our readers that the third International Congress of Tropical Agriculture will be held on Tuesday, June 23rd, to Tuesday, June 30th, 1914, at the Imperial Institute, South Kensington. The principal object of the Congress is the discussion of ways and means of improving agriculture in the Tropics and thereby increasing the production of the numerous foodstuffs and industrial raw materials derived from tropical countries—matters which are of vital interest to the trade and industries of the United Kingdom.

PRESS PHOTOGRAPHY.—A long-felt want is about to be satisfied by Messrs. A. & C. Black with a complete practical manual of Press photography, entitled " Photographs for the Papers: How to Take and Place them," by John Everard. The book is intended alike for the beginner in Press photography, the photographer wishing to take up the journalistic side of his profession, the journalist anxious to add photography to his literary work, and the amateur desirous of making his hobby pay. Considerable space is devoted to the daily, weekly, and monthly publications, and the different kinds of photographs suited to each.

THE BECK BINOCULAR MICROSCOPE.—We have received from Messrs. R. & J. Beck a booklet describing their new binocular microscope, which, it is claimed, has resolving power equal to that of a monocular, into which it can be converted by a touch. The cone of light entering the objective is not divided in the ordinary way, but allowed to impinge upon a silvered surface, which allows some of it to pass through to one ocular and the rest to be reflected to the other. As the transparency and reflecting power of the surface can be regulated, it is possible to ensure that each eye gets the same illumination, whereas in the old type of binocular the light that reaches one eye is of only about one-sixth the intensity of that which goes to the other. Any objectives or eyepieces may be used, the body tube is short, stereoscopic effects can be obtained, and the danger of eye-strain is removed.

SWEDENBORG'S PHILOSOPHY. — On Friday, February 27th, a lecture on " The Body and the Soul in Swedenborg's Philosophy " was delivered by Monsieur L. de Beaumont-Klein, D.Sc., under the auspices of the Swedenborg Society. The chair was occupied by the Honorary President, Sir W. F. Barrett, F.R.S.

The lecturer gave a detailed account of Swedenborg's physiological and psychological doctrines in relation both to the views of his contemporaries and the latest products of modern thought. Swedenborg, he pointed out, held very advanced views on the functions of the spinal cord and brain. Reference was also made to spontaneous generation, which the lecturer said might be considered as a biological fact, though not necessarily in opposition to the principle that Life is the one source of life.

Proceeding to psychology the lecturer advanced to Swedenborg's fundamental conclusion that the human soul is a spiritual substance and form intended to receive life from God, and he pointed out that Swedenborg's doctrine of spiritual influx supplied that ultimate continuity which modern philosophy was seeking. Amongst other highly interesting points dealt with were Swedenborg's analysis of the soul into understanding and will, and the unequal grades of development of which these two elements are capable; also Swedenborg's distinction between two memories in man—a spiritual and a natural—which seems so much akin to Bergson's distinction between what he terms pure memory and perception.

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